Sponsored by the Office of Naval Research (ONR)

ONR Decision-Support Workshop Series

Transformation...

hosted by the

Collaborative Agent Design Research Center (CADRC)
Cal Poly State University, San Luis Obispo, CA

Proceedings of Workshop held on September 18-19, 2002

at
The Clubs at Quantico, Quantico Marine Base
Quantico, VA

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Preamble

In August of 1998 the Collaborative Agent Design Research Center (CADRC) of the California Polytechnic State University in San Luis Obispo (Cal Poly), approached Dr. Phillip Abraham of the Office of Naval Research (ONR) with the proposal for an annual workshop focusing on emerging concepts in decision-support systems for military applications. The proposal was considered timely by the ONR Logistics Program Office for at least two reasons. First, rapid advances in information systems technology over the past decade had produced distributed, collaborative computer-assistance capabilities with profound potential for providing meaningful support to military decision makers. Indeed, some systems based on these new capabilities such as the Integrated Marine Multi-Agent Command and Control System (IMMACCS) and the Integrated Computerized Deployment System (ICODES) had already reached the field testing and final product stages, respectively.

Second, over the past two decades the US Navy and Marine Corps have been increasingly challenged by missions demanding the rapid deployment of forces into hostile or devastated territories with minimum or non-existent indigenous support capabilities. Under these conditions Marine Corps forces have to rely mostly, if not entirely, on sea-based support and sustainment operations. Operational strategies such as Operational Maneuver From The Sea (OMFTS) and Sea To Objective Maneuver (STOM) are very much in need of intelligent, real-time and adaptive decision-support tools to assist military commanders and their staff under conditions of rapid change and overwhelming data loads. In the light of these developments the Logistics Program Office of ONR considered it timely to provide an annual forum for the interchange of ideas, needs and concepts that would address the decision-support requirements and opportunities in combined Navy and Marine Corps sea-based warfare and humanitarian relief operations.

The first ONR Workshop (***Collaborative Decision Making Tools***) was held April 20-22, 1999 and focused on advances in technology with particular emphasis on an emerging family of powerful computer-based tools. The workshop concluded that the most able members of this family of tools appear to be computer-based agents that are capable of communicating within a virtual environment of objects and relationships representing the real world of sea-based operations. Keynote speakers included: VAdm Jerry Tuttle (USN Ret.); LtGen Paul Van Riper (USMC Ret.); RAdm Leland Kollmorgen (USN Ret.); and, Dr. Gary Klein (Chairman, Klein Assoc.).

The second ONR Workshop (***The Human-Computer Partnership in Decision-Support***) held May 2-4, 2000, was structured in two parts: a relatively small number of selected formal presentations (i.e., technical papers) followed each afternoon by four concurrent open forum discussion seminars. Keynote speakers included: Dr. Ronald DeMarco (Assoc. Technical Director, ONR); RAdm Charles Munns (USN); Col Robert Schmidle (USMC); and, Col Ray Cole (USMC Ret., Program Manager ELB ACTD, ONR).

The third ONR Workshop (***Continuing the Revolution in Military Affairs***) was held June 5-7, 2001 and focused on: the changing role of the military in a post Cold War environment; adaptive interoperable decision-support systems utilizing intelligent collaborating software agents; and, the transitional period. Keynote speakers included Mr. Andrew Marshall, Head of the Pentagon's Office of Net Assessment, and RAdm Jay M. Cohen, Chief of Naval Research, Office of Naval Research (ONR).

The fourth ONR Workshop (***Transformation ...***) described in these Proceedings was held on September 18-19, 2002 at The Clubs in Quantico on the Quantico Marine Corps Base, Quantico, Virginia.

Copies of the proceedings of past Workshops are available free of charge from:

CAD Research Center
Cal Poly (Bdg. 117 T)
San Luis Obispo, CA 93407

Table of Contents

Opening Remarks

as a Foreword to the 4th Annual Office of Naval Research (ONR) Workshop

Good Morning ! I would like to welcome you all to this fourth annual Collaborative Decision-Support Workshop sponsored by the Logistics Program Office of the Office of Naval Research (ONR). I am Jens Pohl, Executive Director of the Collaborative Agent Design Research Center at Cal Poly State University in San Luis Obispo, California. Our Center and Cal Poly has had the honor of hosting this Workshop since 1999, and I thank you for your attendance this year. I believe that we have been able to assemble an excellent program of speakers who will share their expert knowledge and insights with us over the next two days.

Let me say a few words about the purpose of these Workshops. First and foremost, these Workshops are intended to bring together representatives from three communities that have an important stake in information technology (IT):

- The military and civilian users, who use IT as a critical decision-making capability.
- The government agencies that support the development and integration of IT.
- And, industry which actually develops most of the IT products.

Second, these Workshops should identify developing trends, technical limitations that require urgent attention, and opportunities for innovation. In other words, the attendees of each Workshop should go away with a better understanding of the current state of IT and where IT is likely to be headed over the next three years.

Third, the attendees (i.e., representatives of the three communities) should have opportunities for sharing ideas and concerns on a one-to-one, informal basis throughout the duration of the Workshop. These facilities here at The Clubs at Quantico are particularly well suited for such informal interactions. And, this is also why we have catered for and integrated the morning, lunch and afternoon breaks into the Workshop program itself. In other words, we consider them to be an important part of the program.

I would like to recognize Dr. Phillip Abraham of the Office of Naval Research (ONR), who saw the importance of these three purposes and through his vision established this Annual ONR Workshop Series in 1999. Thank you Phil, for your foresight.

The theme of this year's Workshop is ***"Transformation …"***. Much has happened since the last Workshop in June, 2001. Human beings are experienced-based creatures. We feel comfortable with what we know and have already experienced, and we feel most uncomfortable moving outside this experience base. In other words, we are singularly adverse to change. However, we will change, and change with surprising effort and speed, if there are compelling, threatening reasons for changing. The terrorist attacks of Sep.11th last year have certainly provided such reasons, and an atmosphere of profound and accelerating change has pervaded many aspects of our daily activities ever since that cataclysmic event.

I would like to very briefly touch on four major areas of change that are potentially transformational in scope:

1. ***From data-processing to information-centric software:*** We are rapidly transitioning from data-processing to intelligent information management in IT. The ability to store information (i.e., data with relationships that provide context) in computer software provides the basis for automatic reasoning and learning capabilities. Over the next three to six years computer systems will become sufficiently smart to enter into meaningful and immensely valuable collaboration with human users.

2. ***From centralized to distributed services:*** For reasons of safety and security we will be moving to a much more diversified resources and services model. The greater the concentration of value, the more attractive the target! Under current threat conditions we simply cannot afford to offer those who harbor ill will against us high value concentrated targets such as centralized water, electric power, transportation, and communication hubs.

The other two areas of major change are at least indirectly related to this second area of change:

3. ***From singularity to plurality:*** Networking is becoming a principal agent for implementing a diversified resources and services model, for two reasons: first, to provide the necessary connectivity; and second, to fully exploit the opportunities for the widest distribution of resources and capabilities. And, of course, as we build these distributed networks we will incorporate a level of redundancy that will provide an acceptable degree of reliability and graceful degradation.

4. ***From hierarchical to flattened organizational structures:*** The notion of networking is not restricted to physical communication facilities. Included in this notion are also the formal and informal human interactions that are the life-line of our organizational models. These organizational structures are becoming flat and web-like as the focus increasingly shifts from the organization to the individual. We have entered an era during which the contributions of the greatly enabled individual are rapidly becoming the most valuable asset of the organization.

Leaving these brief thoughts with you as we begin our Workshop program, I would like to call on my colleague and friend Col Tony Wood (USMC Ret.) to introduce our distinguished keynote speaker this morning, Vice Admiral Jerry Tuttle (USN Ret.).

Jens Pohl, Executive Director
Collaborative Agent Design Research Center,
California Polytechnic State University (Cal Poly), San Luis Obispo

Quantico, September 18, 2002

Fourth Annual ONR / CADRC Decision-Support Workshop

September 18-19, 2002, Quantico, Virginia

The Office of Naval Research
and
The Collaborative Agent Design Research Center
Cal Poly, San Luis Obispo

"Transformation..."

The impact of intelligent, collaborative, information-centric software systems on:
... tactical command and control
... logistic command and control
... transportation management
... intelligence analysis/evaluation

Wednesday, September 18:

Time	Activity
7:30	**Check-in and Registration Begins** Registration Desk open from 7:30 AM to 4:30 PM
8:30 - 8:45	**Opening Remarks and Welcome** **Dr. Jens Pohl**, Executive Director, Collaborative Agent Design Research Center, Cal Poly, San Luis Obispo, California
8:45 - 9:45	*Keynote Address:* **"Transformation vs. Risk Management"** **VAdm. Jerry Tuttle** (USN Ret.), President and CEO, J.O.T. Enterprises LLC
9:45 - 10:00	**Break**
10:00 - 10:30	**"***Transformation... a State of Mind?***"** **Col. Tony Wood** (USMC Ret.), CDM Technologies, Inc., San Luis Obispo, California

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Wednesday, September 18 (continued):

Time	**Activity**
10:30 – 11:00	*"The Littoral Combat Future Naval Capability Program"* **Col. Thomas O'Leary (USMC Ret.)**, Program Manager, Office of Naval Research
11:00 – 11:30	"*The Joint Task Force Wide Area Relay Network (JTF WARNET)"* **Raymond Cole, Jr.**, JTF Warnet Technical Manager, Office of Naval Research
11:30 - 1:00	**Lunch**
1:00 – 2:00	*"The Role of Discovery in Context-Building Decision-Support Systems"* **(Demonstration of a Semantic Web application with discovery, reasoning and learning capabilities)** **Steve Gollery,** Software Engineer**, Jens Pohl**, Executive Director, Collaborative Agent Design Research Center, Cal Poly, San Luis Obispo, California
2:00 – 2:30	*"Exploiting Taxonomic Reasoning in Support of Real-Time Mission Reachback Processes"* **Dr. David Aha**, Computer Scientist, Naval Research Laboratory, Washington DC
2:30 – 2:45	**Break**
2:45 – 3:15	*"An Analysis Tool Suite for Management and Reuse of Ontologies"* **Mala Mehrotra**, President, Pragati Synergetic Research, Inc., Cupertino, California
3:15 – 3:45	*"Data, Information, and Knowledge in the Context of SILS"* **Michael Zang,** Software Engineer, CDM Technologies, Inc., San Luis Obispo, California
3:45 – 4:15	"*Collaborative Role of Data Analysis and Inspection Technology in Improving Supply Chain Security"* **Dr. Larry Mallon**, Director, CITT and **Dr. John Hwang**, Associate Professor of Business (MIS), Long Beach State University, California
4:15	**(CLOSE DAY ONE)**
5:00 – 7:00	**Social in Ballroom 3**
7:00 – 9:00	**Speakers' Dinner in Ballroom 4 (by invitation)**

Thursday, September 19:

Time	Activity
7:30	**Check-in and Registration Continues** Registration Desk open from 7:30 AM to noon.
8:30– 9:45	*Keynote Address:* **"Homeland Security: A View Through the Eyes of Janus**" **Mr. Steven I. Cooper,** Special Assistant to the President, Senior Director for Information Integration and CIO and Lee Holcomb, Director of Infostructure, Office of Homeland Security
9:45 – 10:00	**Break**
10:00 – 10:30	*"Transformation... CETO Style!* **Col. Ki Harvey (USMC Ret.),** Deputy Director, Center for Emerging Threats and Opportunities, Dumfries, Virginia
10:30 – 11:00	*"Transformation...Intelligent Logistics Information Management* **Chris K. Neff,** Logistics Program Analyst and Ships Operations Program Manager; Commander in Chief U.S. Pacific Fleet
11:00 – 11:30	"*3D Battlespace Visualization with Live Video Overlays"* **Dr. Peter Burt**, Sarnoff Corporation, Princeton, New Jersey
11:30 – 1:00	**Lunch**
1:00 – 1:30	**"***The Future of Training and STOW (Synthetic Theater of War)"* **Dr. Michael P. Bailey**, Technical Director, Training and Education Command, MCCDC
1:30 – 2:00	*"'Pushing the Border Out:' Creation of the 'Virtual' Electronic Border"* **Robert Quartel**, Chairman and CEO, FreightDesk Technologies, Former Member, U.S. Federal Maritime Commission
2:00 – 2:30	**"***Joint Military/Civilian Incident Command Systems for Homeland Defense"* **Dr. Thomas Bevan**, Director, Homeland Defense Initiative, Georgia Institute of Technology, Atlanta, Georgia
2:30 – 2:45	**Break**
2:45	**Workshop Wrapup** **Dr. Phillip Abraham**, Office of Naval Research
	(CLOSE DAY TWO)

Dr. Phillip Abraham
Logistics Program Office
Office of Naval Research

Dr. Abraham is a Scientific Officer at the Office of Naval Research (ONR). For the past eight years, starting in 1994, he has managed the ONR Science and Technology (S&T) Logistics Program. A major endeavor during these years was the introduction of S&T projects in a program that at the time depended on old technologies. In this he was guided by the view that the goal of military logistics is readiness everywhere , at all times. Toward this goal he introduced state-of-the-art sensors (e.g., MEMS), intelligent agents for decision support systems, and other innovations in both hardware and processes. Under his management the Logistics Program has addressed a host of areas that needed S&T attention. These included Maintenance (where sensor monitoring and diagnostics of systems replaces fixed schedule checkups and overhauls), Underway Replenishment (the goal being operation in sea states 3 and higher via technical improvements to existing crane systems, as well as the development of new systems that will eventually replace the conventional cranes), Amphibious Logistics (Seabasing is the major goal here and the tools that will enable the integration of the sea and shore operations are the SEAWAY and LOGGY projects that have received support from both the Navy and the Marine Corps), Naval Facilities (the major thrusts in this area were the operation of the naval bases, the rehabilitation of the deteriorating naval piers, the design of modular hybrid piers, and the design and construction of high performance ordnance magazines), Decision Support Systems (the goal in this area is to provide to the CO, at any level of command, a decision system based on state-of-the-art collaborative intelligent agents and tailored to the needs of that level), and Integration (the goal here is the integration of all the systems on a single navy platform, a squadron, a battle group, a fleet, &c., that will result in the highest achievable state of readiness. A current project, "Mission Readiness Analysis", addresses the challenge of systems integration on a single platform).

Dr. Abraham joined the Office of Naval Research in 1989 as a member of the Mechanics Division where he was in charge of the ONR 6.1 Structural Acoustics Program, the goal of which was minimizing the emission and scattering of sound by submarines. Based on his own prior work while employed by Raytheon Co. (see below), he introduced the idea of working in the time domain in computations related to the response of complex elastic structures to internal and external excitations. This allowed the computation of the response of models of submarines with internal structure in (almost) real time and reduced the demands on computer hardware. This work was performed at the University of Texas (Austin) and Stanford University (Palo Alto) using the most sophisticated computational techniques (of the time) for large scale problems.

From 1982 until 1989 Dr. Abraham was a member of the Naval Research Laboratory where he did research on fluid-structure interactions, and on wave propagation phenomena. He studied the propagation of acoustic waves in inhomogeneous and random media, and showed how to obtain results, to all orders, for both weak and strong inhomogeneities. This work, and work on reflection tomography, were motivated by the need to detect passively or actively targets in regions of the ocean that are contaminated by random distributions of biological and other scatterers.

In 1974 Dr. Abraham started working at the Naval Underwater Sound Laboratory in New

London, Connecticut. There his research dealt with underwater acoustics, focusing on detection and localization of underwater targets. Among other topics, he determined the influence of size on magnetic anomaly detection (MAD) of ferromagnetic targets (such as submarines). In addition he, and Dr. H. Moses, used inverse scattering theory to generate new families of sound velocity profiles (in the ocean) for which the wave equation has exact solutions. These were useful later on in determining acoustic wave propagation in the arctic ice cap. This work also led to concurrent results for potentials appearing in the Schrodinger equation of Quantum Mechanics. One of these potentials, a nontrivial modification of the harmonic oscillator potential, has been referred in the literature as the Abraham-Moses potential.

From 1970 until 1974, Dr. Abraham was an Assistant Professor of Physics at the University of Connecticut, where he taught and worked on Nonlinear Dynamics problems related to solitons.

During 1968-1970, Dr. Abraham was employed by Raytheon Company in New London, Connecticut. There he worked on acoustic imaging in fluid media using an exact analytic approach for solving wave equations in the time domain. A concurrent laboratory experiment yielded a visual image, on a TV screen, of an insonified, submerged object. At that time, it was the first such image generated with acoustic waves.

In 1966 Dr. Abraham was granted a Postdoctoral Research Associateship by the National Research Council. Located at NASA's Goddard Space Flight Center, he worked on propagation of charged particles (originating from solar flares) through the interplanetary magnetic field. The results of the theoretical work matched quite well with experimental results obtained from high-altitude balloon flights.

Dr. Abraham was awarded the Ph.D. in Physics by the University of Maryland in 1966. His thesis topic was in Solid State Physics, and it dealt with generating exactly solvable models of crystal lattices, which were used subsequently to check perturbation methods employed in the treatment of actual crystals. Among the results obtained was a new method of evaluating finite and infinite sums that appear in various areas of physics.

In 1960, Dr. Abraham was awarded the M.Sc. degree in Physics by the Hebrew University in Jerusalem, Israel. His Master Thesis (in atomic spectroscopy) dealt with the computation of the energy levels of isoelectronic sequences of atoms in various configurations. The results of these computations reside in the tables published during the sixties by NIST (then NBS), under the editorship of Dr. Charlotte Moore.

Dr. David W. Aha
Computer Scientist
Naval Research Laboratory

Dr. David W. Aha leads the Intelligent Decision Aids Group at the Naval Research Laboratory's Center for Applied Research in Artificial Intelligence (AI), located in Washington, DC. His group's projects, concerning the research and development of decision support tools, use a variety of AI-related methodologies and techniques (e.g., mixed-initiative planning, case-based reasoning (CBR), knowledge management, machine learning, textual data mining). With respect to these interests, he has published over 80 times in scientific journals and conferences, has given keynote presentations at several international (technical) conferences, has (co-)organized eleven international conferences/workshops

(e.g., ICCBR'01), has served on the editorial boards for three journals, and has served on many AI conference program committees.

Dr. Michael P. Bailey

Technical Director, Training and Education Command, MCCDC

Dr. Michael Page Bailey currently serves as the Technical Director for the Technology Division, Training and Education Command, Marine Corps Combat and Development Command, Quantico, Virginia. He graduated from the University of North Carolina at Chapel Hill with a Ph.D in Operations Research in 1988, and became an Assistant Professor of Operations Research at the Naval Postgraduate School in Monterey, California. He was promoted to Associate Professor in 1993 and tenured in 1994.

In 1995, he sabbaticaled at the Office of the Chief of Naval Operations, Assessments Division, OPNAV-N81 as a visiting scholar. There he served as operations analyst in support of the Quadrennial Defense Review until 1997, whereupon he joined the Marine Corps as Principal Analyst, Modeling and Simulation. In December 1999, he joined the Marine Corps' Training and Education Command as Technical Director. In December 2000, the Marine Corps formed the Training and Education Technology Division, with Dr. Bailey as its head. Technology Division is responsible for requirements, policies, and sponsorship of all technology applicable to Marine Corps individual training, unit training, exercises, and ranges. These technologies include interactive multimedia distance learning, weapon system and crew training simulators, simulation, interactive gaming, instrumentation, and classroom technology.

Dr. Thomas E. Bevan

Director, Homeland Defense Initiative, Georgia Institute of Technology

In 2001, Dr. Thomas Edward Bevan was appointed by Georgia Tech President G. Wayne Clough to the newly created position of Director of Homeland Defense at the Georgia Institute of Technology. In this position he is responsible for applying Georgia Tech technology to Homeland Defense and counterterrorism. Dr. Bevan is also Director of the Center for Emergency Response Technology, Instruction, and Policy (CERTIP) at Georgia Tech. Dr. Bevan founded CERTIP three years ago as a public-private partnership to foster basic and applied research to enhance emergency response and consequence management for both natural and human-caused disasters of mass destruction. CERTIP is funded in part by the U.S. Marine Corps Warfighting Laboratory and the Marine Corps Systems Command in Quantico, Virginia. Research at CERTIP focuses on chem/bio terrorism and natural disasters. Dr Bevan also serves on the Emergency Response Task Force which is involved in creating, updating, and coordinating campus security policies and procedures that are applicable to the entire campus, including the updating of the 1996 Atlanta Olympic Games security policies and procedures.

Dr. Bevan is also the Associate Laboratory Director of the Electro-Optics, Environment, and Materials Laboratory (EOEML) at the Georgia Tech Research Institute. In this capacity, he provides management and leadership for a 200-person laboratory that oversees and conducts research in a wide variety of business areas including the environment, opto-electronics, undersea acoustics, and food processing. Dr. Bevan is responsible for customer contacts with agencies in Washington, D.C. and private industry.

Dr. Bevan graduated cum laude as an undergraduate Psychology major at Dartmouth College. He was a distinguished military graduate at Dartmouth in the Army ROTC Program. In 1973 Dr. Bevan earned his Ph.D. in experimental Psychology from Princeton University. After graduation, he worked as a program manager for the Command and Control Division of Science Applications International Corporation in Arlington, Virginia where he worked on several DARPA programs. During the next eighteen years, he developed, managed and supervised special programs in the radar laboratory and in the imagery applications business area at the Environmental Research Institute of Michigan, also based in Arlington, Virginia. In 1999, he relocated to Atlanta to join researchers at the Georgia Tech Research Institute.

Dr. Peter Burt
Sarnoff Corporation

Dr. Peter Burt is managing director of the Vision Technologies Business Unit at Sarnoff Corporation. This activity is devoted to the development of advanced technologies for the real time analysis of video for such applications as vehicle guidance and surveillance and targeting. It has pioneered innovations in embedded processors as well as real time analysis algorithms.

Dr. Burt received the B.A. degree in physics from Harvard University in 1968, and the Ph.D. degree in computer science from the University of Massachusetts, Amherst, in 1976. As a Postdoctoral Fellow he has studied both natural and computer vision at New York University, Bell Laboratories, and the University of Maryland. He conducted research in sonar, particularly in acoustic imaging devices, at the U.S. Navy Underwater Systems Center. He was a member of the engineering faculty at Rensselaer Polytechnic Institute. In 1983 he joined the Sarnoff Corporation (formerly David Sarnoff Research Center).

Dr. Burt has pioneered a number of multiresolution techniques for real-time vision and is the author of many technical papers in this area. He received the David Sarnoff Award for Outstanding Technical Achievement in 1992.

Raymond Cole, Jr.
JTF WARNET Technical Manager

Mr. Cole has worked for over thirty years at the Naval Research Laboratory in the area of Information Technology. He heads up the Integrated Communication Technology Section of the Communication Systems Branch. He is the Technical Manager for JTF WARNET which is a two year effort to field an Operational Prototype to PACOM that will provide a translation and communication capability that will enable joint fires and maneuvers.

Steve Gollery
Software Engineer
Collaborative Agent Design Research Center

Steven Gollery is employed as a Senior Software Engineer at the Collaborative Agent Design Research Center at the California Polytechnic University, San Luis Obispo California. Mr. Gollery has been developing software for twenty years, beginning with assembly-language programming for the 6502 on some of the earliest home computers, an experience that he does not look back on with nostalgia. He continues to be engaged by the relentless pace of change in the software industry, and believes that the emerging web service standards will be a driver for ever more rapid innovation.

Steven I. Cooper
Special Assistant to the President
Senior Director for Information Integration and CIO, Office of Homeland Security

Mr. Cooper joined the Office of Homeland Security in March 2002. He brings more than twenty years of experience as an Information Technology professional, most recently as CIO, Corporate Staffs, and Executive Director, Strategic Information Delivery for Corning, Inc. in Corning, NY. Prior to that he was Director, Information Technology for Eli Lilly & Company in Indianapolis, IN. Mr. Cooper held several senior level technical and management positions with CSC, MAXIMA, and CACI prior to forming his own consulting organization, Strategic Information Concepts.

His primary areas of expertise lie in Information Integration, Strategic Information Delivery, Information Technology Architecture, Enterprise Application Integration, Application Development, Information Technology Metrics and Value Assessment, and Process Architecture and Reengineering.

In his role within the Office of Homeland Security, Mr. Cooper will be responsible for guiding the development of information integration architectures and roadmaps that will integrate the information "stovepipes" within the federal government and will enable the sharing of homeland security information with state, local, and relevant private sector entities. This will be achieved by integrating new and existing sources of essential information via proven and emerging technologies and in full compliance with our broader values of privacy, civil liberties, and openness.

Mr. Cooper holds a BA degree from Ohio Wesleyan University, and has held professional certification as a Certified Computer Professional (CCP) from the Institute for the Certification of Computer Professionals (ICCP). He also served in the Naval Reserve during the Vietnam Era.

Dr John F. Halldane
Planning and Environmental Systems Consultant

Dr Halldane is an interdisciplinary systems consultant developing freeways with towns in SE Asia, urban design, business planning, matrix management systems, contingency planning with trend analysis, predicting building collapse and technology assessment. He provides integrated professional services to plan-incorporate-finance-design-build-operate-manage projects. Provides expert testimony in technology assessment cases.

During the oil embargo Dr Halldane was a Senior Physical Scientist with the Federal Energy Administration which was radiply created to meet that crisis and could be a model for our national security administration today. He was Chief of the Psychophysics Section in Building Research at the National Bureau of Standards involved with people's perception in buildings, Colorimetry, tire noise for the DOT, thermal transfer in TriService contracts, lighting in coal mines for BOM. He was a Visiting Professional in daylighting programs at the Solar Energy Research Institute; military dining halls for the Construction Engineering Research Laboratory and energy conservation measurement at the Oak Ridge National Laboratory. Consultant for sound measurement with OSHA.

Recently he returned from over a decade working out of Singapore around SE Asia. He was a Professor and Senior Research Fellow with the Institute Sultan Iskandar for Urban Habitat and Highrise, Universiti Teknologi Malaysia, involved as a town

planner and urban designer for four cities and the Muar District and in Architecture at the National University of Singapore. Team founder of the South East Asia Centre for Environmental and Urban Management known for the annual Leadership Seminar and Urban Monograph Series. He was a Professor in Environmental Design at CalPoly Pomona, UC Berkeley, U.British Columbia and lectured in Architectural Science at U.Sydney and Architecture at U.Newcastle. He developed and lectured in Facility Management Systems, presented 2-day Seminars in Singapore, Hong Kong and Kuala Lumpur; and with the MMC Professional Centre in Singapore.

Dr Halldane has degrees from New Zealand; a PhD (Architecture/Visual Perception), B.SC. (Applied Mathematics. Physics), Dip,T.P. (Town Planning), B Arch with Hon (Architecture). He was a registered architect FRAIA, ANZIA; a lighting engineer MIES; psychophysicist (HFS). Dr Halldane is a US Citizen has published over 130 extensive articles on interdisciplinary topics.

Col. Ki Harvey, (USMC Ret.)
Deputy Director
Center for Emerging Threats and Opportunities

Ki Harvey is currently the deputy director for the Center for Emerging Threats and Opportunities (CETO), a Marine Corps think tank that examines emerging threats to national security. Mr. Harvey oversees business administration and contract issues, in addition to managing the operations staff. Previously, he was assigned as an IPA (Intergovernmental Personnel Act) from the Potomac Institute to the Office of Naval Research as Head of System Engineering and Integration for the Extending the Littoral Battlespace Advanced Concept Technology Demonstration (ELB ACTD).

Prior to his employment with the Potomac Institute, Mr. Harvey was a senior systems analyst at VisiCom Laboratories where he was responsible for Wargaming, Simulation, and Command and Control systems. In his five years at VisiCom, Mr. Harvey worked as a subcontractor on several projects including: the Communications/Navigation Integrated Product Team for the Marine Corps' Advanced Ambhibious Assault Vehicle (AAAV); the "Extending the Littoral Battlespace," Advanced Concept Technology Demonstration sponsored by the Office of Naval Research; and the Marine Air Ground Task Force (MAGTF) Staff Training Program (MSTP) at the Marine Corps Base Quantico.

From September 1970 to April 1994, Mr. Harvey held various positions in the U.S. Marine Corps, including:

- Program Manager, Marine Corps Systems Command (December 1989 - April 1994)
- Commanding Officer, First Light Antiaircraft Missile Battalion (March 1987 - May 1989)
- Commanding Officer, Second Low Altitude Air Defense Battalion (April 1985 - February 1987)
- Aide-de-Camp, Commanding General, Fleet Marine Force, Pacific (June 1983 - June 1984)

Mr. Harvey has an M.A. in Human Resources Management from Pepperdine University (1978) and a B.A. in Political Science from Tarkio College (1970).

Dr. John Hwang
Assoc. Professor of Business (MIS)
Long Beach State University, California

John D. Hwang received his B.S. in electrical engineering from University of California-Berkeley; M.A. and Ph.D. in mathematics from Oregon State University. Before

joining the faculty at California State University - Long Beach in 1999, he was General Manager of Information Technology Agency, City of Los Angeles, California. His 30-year career in the U.S. federal government included posts in Department of Defense in developing strategic command-and-control systems; Executive Office of U.S. Vice President, leading a team to re-invent the US transportation systems; and Federal Emergency Management Agency, Washington, D.C., where he was Executive Associate Director to apply Information Technology to enhance emergency preparedness and response.

Dr. Larry Mallon

Attorney at Law
Director CITT, Long Beach State University, California

Lawrence G. Mallon received his B.S./B.A. from Georgetown University; his J.D. from Emory University; and his LL.M. in ocean and coastal law from the University of Miami. He is admitted to practice law in Georgia, District of Columbia, New York, and California. Since 1987, he has been Managing Principal in Lawrence G. Mallon & Associates, San Clemente, California, providing legal and international business consulting services. Prior, he was Maritime Counsel to the Committee on Merchant Marine and Fisheries of the U.S. House of Representatives, Washington, DC. He has served as Congressional observer to United Nations International Maritime Organization, and Third United Nations Law of the Sea Conference.

Mala Mehrotra

President, Pragati Synergetic Research, Inc.

Mala Mehrotra is the founder and President of Pragati Synergetic Research, Inc., a small business located in Cupertino, CA.which will celebrate its 10th anniversary next year. Since its inception in 1993, Pragati Inc. has been performing high-end artificial intelligence research for mainly government clients such as, DARPA, Air Force, Navy, NSF, and Department of Transportation.

Ms. Mehrotra has an M. S. degree in Computer Science with concentration in artificial intelligence and parallel computing from the College of William and Mary in VA. In addition she also has an M.S. in Nuclear Physics from Delhi University, India. Her B.S. degree was in Physics (Hons) from Calcutta University, India. She has been the recipient of several SBIR awards from NASA, NSF, and AF. As an on-site contractor at Systems Validation and Methodology Branch (SVMB), NASA Langley Research Center in Hampton, VA from Œ89-93, Ms. Mehrotra developed various methodologies for software engineering of knowledge-based systems. She has been the main architect of the Multi-ViewPoint Clustering Analysis Tool, MVP-CA tool which partitions large and complex knowledge-based systems into meaningful units for the purpose of analyzing them. MVP-CA tool was used in analyzing IMMACCS (Integrated Marine Multi-Agent Command and Control System, sponsored jointly by the Marine Corps Warfighting Laboratory (MCWL) and the Office of Naval Research (ONR)). Under current ONR funding she is spearheading an effort to build a facade creation toolkit (FCT) for manipulation of ontologies in knowledge based systems such as IMMACCS, SILS (Shipboard Integration of Logistic Systems), and OTIS (Ordnance Tracking Information System), for the purpose of reusing these ontologies.

Christopher K. Neff
Logistics Program Analyst and
Ships Operations Program Manager
Commander in Chief U.S. Pacific Fleet

Chris Neff has served as the principal logistics program analyst for the U.S. Pacific Fleet since May 1999. During this period he has been responsible for identifying material, services, information management needs and resources necessary to support the Pacific Fleet's Aircraft Carriers, Surface ships, and Submarines. He has also provided both functional and technical support to fleet support agencies in order to increase information accuracy, streamline processes, and enhance decision support. He has provided the Office of Naval Research and associated contractors with logistics-related process improvement ideas and placed emphasis on those areas which will provide the greatest value. Prior to assuming his current position Mr. Neff served as the principal Base Operating Support (BOS) program analyst for facilities, equipment and base support services throughout the Pacific Fleet area of responsibility from Nevada to the Indian Ocean.

Mr. Neff enlisted in the U.S. Navy in 1969, achieved the rank of E-5 prior to being selected for the Navy's Enlisted Scientific Education Program (NESEP), where he earned a Bachelor of Engineering degree in Computer Science at the University of New Mexico. In 1975 he was commissioned and assumed duties as the Electronic Material Officer on the Pacific Fleet Frigate USS Davidson subsequently became Supply Officer on the San Diego-based USS O'Callahan. His 21 year Naval Career included assignments as Accounting Officer, Financial Management Officer, Financial Systems Project Director, Fleet Budget Officer, and Comptroller on the staffs of the Commander, U.S. Surface Force Pacific Fleet, Chief of Naval Operations, Officer of the Navy Comptroller, the Pacific Fleet Commander, and Commander Naval Logistics Command, Pacific. His private-sector experience includes property management, condominium asset management, hotel operations management, property development, and comptroller.

Col. Thomas M. O'Leary (USMC Ret.)
Program Manager, Office of Naval Research

Mr. O'Leary currently is the Program Manager for the Littoral Combat Future Naval Capabilities program at the Office of Naval Research. He is on an IPA assignment from the Potomac Institute for Policy Studies where he is a Senior Research Fellow. Prior to joining the Potomac Institute for Policy Studies, he was a Research Staff Member at the Institute for Defense Analyses where he was the Task Leader for the Joint Study on Effects Based Operations. Prior to joining the Institute for Defense Analyses, he was a Marine Infantry Officer and served in a variety of staff billets and commanded at the company, battalion, and MAGTF levels. He received a Bachelor of Science degree from the Georgia Institute of Technology, a Master of Science degree from the University for Southern California, and a Master of Arts degree from the Naval War College.

Dr. Jens G. Pohl
Executive Director, Collaborative Agent Design Research Center, and Graduate Coordinator, Architecture Department, Cal Poly, San Luis Obispo, California

Dr. Jens Pohl holds the positions of Professor of Architecture, Executive Director of the Collaborative Agent Design Research Center (CADRC), and Post-Graduate Studies

Coordinator, in the College of Architecture and Environmental Design, California Polytechnic State University (Cal Poly), San Luis Obispo, California, US.

Professor Pohl received his formal education in Australia with degrees in Architecture and Architectural Science: B.Arch. (University of Melbourne, 1965) M.Bdg.Sc. and Ph.D. (University of Sydney 1967 and 1970). He taught in the School of Building at the University of New South Wales in Sydney, Australia, until the end of 1972 and then left for the US where he was appointed to the position of Professor of Architecture at Cal Poly. Following several years of research and consulting activities in the areas of building support services and information systems, Dr. Pohl's research focus today lies in the application of distributed artificial intelligence methodologies to decision-support systems in engineering design, logistical planning, and military command and control.

Under his direction the Collaborative Agent Design Research Center at Cal Poly has over the past 11 years developed and implemented a number of distributed computing applications in which multiple computer-based and human agents collaborate in the solution of complex problems. Foremost among these are the ICDM (Integrated Cooperative Decision Model) and TIRAC (Toolkit for Information Representation and Agent Collaboration) frameworks which have been applied to engineering design (industry sponsorship: ICADS - 1986 to 1991), energy conservation (US Dept. of Energy sponsorship: AEDOT - 1992 to 1993), logistical planning (US Army (MTMC) sponsorship: ICODES - 1993 to present), military mission planning (US Marine Corps (MCWL) sponsorship: FEAT, FEAT4 and IMMACCS - 1994 to present), and facilities management (US Navy (ONR) sponsorship: CIAT, SEAWAY, and LOGGY - 1996 to present).

The Integrated Marine Multi-Agent Command and Control System (IMMACCS) was successfully field-tested as the command and control system of record during the Urban Warrior Advanced Warfighting Exercise (AWE) conducted by the Marine Corps Warfighting Laboratory (MCWL) in Central California (Monterey and Oakland) during the period March 11 to 18, 1999, during a live fire Limited Objectives Exercise (LOE) held at Twentynine Palms, California, in March 2000, and during the recent Kernal Blitz Exercise held on the West Coast in June 2001. The Integrated Computerized Deployment System (ICODES) was designated by the US Department of Defense as the 'migration system' for ship loading in July 1995. ICODES V.3 was released to the US Army in 1997 and ICODES V.5 is being released to the US Marine Corps and US Navy this year (2002).

Dr. Pohl is the author of two patents (US), several books, and more than 80 research papers. He is a Fellow of the International Institute for Advanced Studies in Systems Research and Cybernetics, and was awarded on honorary doctorate by the Institute in August, 1998, during the InterSymp-98 conference held in Baden-Baden, Germany. Professor Pohl is a Fellow of the Royal Australian Institute of Architects, a Fellow of the Australian Institute of Building, a Member of the American Institute of Constructors, and a member of IEEE.

Donald R. Quartel, Jr.
CEO, FreightDesk Technologies

Rob Quartel (Donald Robert Quartel, Jr.) is a former Member of the US Federal Maritime Commission, and an internationally recognized expert in US national maritime and transportation policy. He currently

serves as Chairman and CEO of FreightDesk Technologies, named by Forbes Magazine in 2000 as "one of the ten best" in logistics on the web. The company is a lead developer of internet-based Transportation Management System applications for international cargo management. It provides its software solutions to shippers, 3PL's and other transportation providers for the comprehensive execution of international freight. Mr. Quartel's experience spans a wide range of energy, transportation, safety and environmental regulatory matters and a number of public-private ventures including mass transit, high-speed rail, highway, aviation and port development projects. He is a prolific and sometimes controversial writer and speaker, frequently cited in the media and called upon by the United States Congress for expert testimony; and he was the leading proponent of international liner shipping deregulation, which passed in 1998. He has been a Lecturer at Yale University's Graduate School of Management, teaching a course on Transportation Strategy and Management; and continues to serve as a Member/Advisor to the Army Science Board on Strategic Sealift and "Army After Next" issues. Mr. Quartel is also a Member of the Board of Advisors to the Woodrow Wilson International Center, sits on the board of the Global Electronic Trade Association, and was a member of the Bush-Cheney Transition Advisory Committee to the US Department of Transportation. He has taken an active role in developing a public policy response to the issue of international container security, and was the first to publicly describe the concept of "pushing the borders out" via a "virtual" electronic data border that would allow government officials to profile cargoes prior to embarkation to the United States.

Dr. Gordon Schacher
Naval Postgraduate School, Monterey, California

Dr. Schacher's formal education was in Physics, principally solid state. After joining the Naval Postgraduate School, he transitioned into radar attenuating materials, then electromagnetic propagation in the atmosphere, followed by transport and diffusion with emphasis on chemical and biological warfare. During this work he was Chief Scientist on 11 research cruises. His current work is in operational field experimentation, the design and implementation of operations and systems analysis experiments with operating forces. His focus is on information systems and supporting knowledge structures. He was a member of the scientific panel that developed the remote sensing algorithms for the SEASAT satellite, and was recently a member of the DoD Independent Scientific Panel for Chem/Bio Modeling and Simulation. At NPS he was Chairman of the Physics Dept., Dean of Science and Engineering, Dean of Faculty, and recently was Director of the Institute for Joint Warfare Analysis. He is the author or coauthor of approximately 150 research papers and reports.

VAdm. Jerry O. Tuttle (USN Ret.)
President and CEO, J.O.T. Enterprises LLC

VADM Jerry O. Tuttle was born in Hatfield, Indiana; awarded the American Spirit Honor Medal upon graduation from Enlisted Recruit Training in March 1955; selected for the Naval Aviation Cadet (NAVCAD) Program; and designated a Naval Aviator and commissioned in October 1956. He was Navy's Gray Eagle signifying the earliest designated Naval Aviator on active duty.

His career has included assignments to the staff of the Commander Naval Air Force, U.S. Atlantic Fleet; Attack Squadrons FORTY FOUR, FIFTEEN, ONE TWELVE, ONE SEVENTY FOUR and EIGHTY ONE; Fighter Squadron ONE TWELVE and the Office of the Chief of Naval Operations. He has served as Aide and Flag Lieutenant to the Commander in Chief, U.S. Pacific Fleet. He has commanded Attack Squadron EIGHTY ONE, Carrier Air Wing THREE, replenishment ship USS KALAMAZOO (AOR 6), aircraft carrier USS JOHN F. KENNEDY (CV 67), Carrier Group EIGHT and Carrier Group TWO/Battle Force SIXTH Fleet. He has served as Special Assistant to the Chief of Naval Operations and as Deputy Director for Intelligence and External Affairs at the Defense Intelligence Agency. VADM Tuttle was the Naval Inspector General from August 1984 to November 1985, after which he was Deputy and Chief of Staff for the Commander in Chief, U.S. Atlantic Fleet. In May 1987, he was assigned as Director, Command, Control and Communications Systems, The Joint Staff. In May 1989, he assumed his assignment as Director, Space and Electronic Warfare.

VADM Tuttle's personal decorations include the Defense Distinguished Service Medal; Distinguished Service Medal (2); Defense Superior Service Medal; Legion of Merit (4); Distinguished Flying Cross (3); Meritorious Service Medal (2); Air Medal (23) - five individual and 18 strike/flight awards; Navy Commendation Medal (4); and various campaign awards. He flew over 220 combat missions over North Vietnam, logged more than 500 jet flight hours, and has more than 1,000 arrested carrier landings. He received the 1978 Navy League's John Paul Jones Award for inspirational leadership, the 1983 Association of Old Crows Award for his contributions to electronic warfare, the 1989 AFCEAN of the year in recognition of his contributions to the Armed Forces Communications and Electronics Association (AFCEA), the 1991 American Institute of Aeronautics and Astronautics (AIAA) Command, Control, Communications and Intelligence Award for his contribution to the overall effectiveness of C3I Systems, and the AFCEA 1992 Jon L. Boyes Award for major contributions to that international organization. He was chosen as one of Federal Computer Week's 1991 and 1992 Federal 100. He received the Washington Space Business Roundtable, 1993 Excellence in Government Award. He was inducted into the Government Computer News Information Resources Management Hall of Fame in 1993 and has been selected to receive the 1994 America Astronautical Society Military Astronautics Award.

VADM Tuttle retired from active duty on 1 January 1994.

Col. Anthony Wood (USMC Ret.)
Vice President, CDM Technologies, Inc., San Luis Obispo, California

Colonel Anthony A. Wood (USMC Ret.) joined CDM Technologies in 1998 after 31 years in the Marine Corps. In 1995, he created the Marine Corps Warfighting Laboratory and served as its first director from 1995 to 1998. Colonel Wood also holds the position of Director of Applied Research with the Collaborative Agent Design Research Center at California Polytechnic State University.

In the course of his service, he has been responsible for a number of unique conceptual and practical contributions to joint warfare, naval expeditionary warfare, and our military posture in the Pacific. In 1968, he served his first tour in Vietnam as a platoon commander and then advisor to the Korean Marine Corps Blue Dragon Brigade. In his second tour in Vietnam in 1974-75, Captain Wood commanded a joint-contingent executing clandestine

mission in Laos, Cambodia, and Vietnam. In January 1975, Maj General Homer Smith, USA, the Defense Attache in Saigon, had him transferred to the Defense Attache Office, where has was directed to secretly develop a plan for the evacuation of Saigon. Capt. Wood then executed that plan in April of 1975. Col. Wood has since served in a succession of infantry and reconnaisance command billets and several staff assignments.

As the principal author of the US Navy and Marine Corps "Maritime Prepositioning Concept", he developed a detailed concept and then supervised the implementation of a national strategic response capability based on forward positioning three squadrons of specially configured climate controlled ships. Each of these squadrons contained prepackaged supplies and equipment sufficient to support a force of 15,000 Marines for thirty days. While serving as Chief of Staff Marine Forces Pacific, Colonel Wood was dispatched to Russia in 1993. There, over a two-week period of negotiations, he successfully concluded a major tension reduction agreement and multi-year exercise program with the Russian General Staff, the Commander Russian Pacific Fleet in Vladivostok, and the Commander Russian Far East Military District in Kharbovsk. Designed to relax tensions and reduce the risk of nuclear incidents in the Pacific Theater, the agreement has since been extended.

Colonel Wood's last billet was as founding Director and Commanding Officer of the Marine Corps Warfighting Laboratory from 1995-1998. Unique in its concept-based approach as well as its projection of a very different and non-traditional post cold war future, the laboratory spear headed Marine experiments to recast military capabilities in a mold appropriate to emerging future requirements.

Col. Wood's decorations include the Distinguished Service Medal (multiple awards), the Legion of Merit, the Bronze Star with Combat V, the Meritorious Service Medal, the Joint Commendation Medal (multiple awards), and the Combat Action Ribbon (multiple awards). At the time of his retirement in June 1998, Colonel Wood was the only Colonel or Captain on active duty in any service to have been twice awarded the Distinguished Service Medal.

Michael Zang

Software Engineer
CDM Technologies, Inc., San Luis Obispo, California

Mike Zang is a Senior Software Engineer at the Cal Poly Collaborative Agent Design Research Center. He currently provides technical leadership for the Mission Readiness Analysis Toolkit of the ONR sponsored Shipboard Integration of Logistics program consults on a number of other concurrent projects at the center. Mike began his career at the research center as a core developer on the ICODES project then went on to be the technical leader and principle system architect for the ONR sponsored maritime logistics projects: CIAT, COACH, and OTIS. He introduced the use of case base reasoning at the center and is currently working in collaboration with the NRL's Intelligent Decision Aids Group, a part of the Navy Center for Applied Research in Artificial Intelligence, to extend this technology for the mutual benefit of both organizations. Mike's primary interests are in applied artificial intelligence and ontology development.

Section A: Transforming the Forces

The textual portions of some of the papers in this section are based on audio recordings that have been transcribed and edited by members of the Conference Organizing Committee. These papers typically consist of two sections: the textual transcription of the audio recording; and, a set of PowerPoint slides.

Transformation VS. Risk Management
Fourth Annual ONR Workshop

VAdm Jerry Tuttle (USN Ret.)
President and CEO, J.O.T. Enterprises LLC
Fairfax, Virginia

Good morning! Consigieres, former colleges, masters of the transformation age, dear friends, you who await induction into the Pantheon of American Heroes and are marinated in patriotism, warriors, you who have more degrees than I do college credits, ONR and Collaborative Agent Design Research Center's (CADRC) sagacious masters, ladies and gentlemen.

I possess neither that eloquence of diction, that poetry of imagination, nor that brilliance of metaphor to tell you how much I am pleased to be here, although I do not have a clue as to what I am to say. Because not since that certain kiss at Gethsemani has an audience witnessed a similar betrayal, albeit totally unavoidable. As you are all ineluctably aware, Admiral Herb Browne was to give this keynote address and kick off this extraordinarily important Workshop and only the awesome power of Mother Nature has precluded him from being here. On his behalf, I express his profound disappointment, and I share in your disappointment.

You cannot understand what is really meant, until you have heard it described with the power and imagery of Herb Browne. Herb asked me yesterday if I might substitute for him today, which I readily agreed, because firstly I admire what this forum does and its sublime results, secondly, I am proud to have participated in the past in your Workshops, and lastly and most importantly because Herb asked me. I hold him in the same lofty esteem as Mother Teresa. I am akin to a bush league player pitch hitting for Bobby Bonds. Please marvel at and savor his amazing resume that he has amassed. Although I burped him, I also benefited from his genius.

This annual pilgrimage has become like the county fair as it gets bigger and better every year. When I look in my wake, I am stunned into awe by the panoply of speakers and the brilliance, which they represent. Nevertheless, I am inspired by your confidence, or at least Herb's, awed by the responsibility, but resolved to succeed. Besides, there is some luck in **<u>not</u>** getting what you thought you wanted, -- but getting what you have, -- which once you have gotten it, -- you may see it is what you would have wanted had you known. Ponder that thought for a moment.

Transformation is the current intellectual fashion and discussion topic and has been around subliminally for many years under the perfumed sobriquet of Revolution in Military Affairs, birthed and nourished by the icon, Andy Marshall. Sagaciously, he has for years with great clarity envisioned the necessity to transform our military anatomy toward a faster, more agile, more balanced, more lethal, better informed and more interoperable forces in the endless and relentless pursuit of shared perfect knowledge for which to wage immaculate warfare. He has masterfully harvested the best ideas from the best minds that this great country has to offer. I place in evidence as exhibit one this audience with its celestial knowledge, wide sphere of interest, commitment, vast experience and extraordinary intellect.

Andy has been flawless, except for his position on carriers in which he is totally incorrect. The aircraft carrier with the long lance of naval air is the most awesome, malleable and versatile weapons system on earth and the proteus of all weapons systems. It is a hybrid creation, which enables us to conquer land, sea and air simultaneously. It is the quintessence embodiment of presence, power, and precision. But, enough on that issue for fear that you detect a bias. However, it remains a mystery to me why he rejects the obvious and not succumbs to the straitjacket of reality. But, not since that certain stroll across the Sea of Galilee has anybody else been perfect.

Upon the arrival of our current brilliant, courageous, inspirational and energetic Secretary of Defense, the transformation journey commenced. I can make that statement now that I am out of uniform, of which I could never get back into, without being thought a sycophant, and because I do so without any calculations of profit or loss, relying solely on my conscience. As we commence our journey into the future on the wings of transformation, may it be a journey that we can look forward to with unbridled enthusiasm and a journey that we can look back upon with pride of accomplishment and with confidence in our security.

There are three ways to change a culture. One is to change the people; two, change the rewards system and thirdly, experience a cataclysmic event. SECDEF courageously was addressing the first two ingredients, but was working against the inert mass, the bureaucratic indigestion and the resistance to change and frankly had not enjoyed too much success, even as capable and charismatic as he is. But, on that horrific day leeward of over a year ago, the third nutrient for transformation was given an overdose and the world was changed forever.

The rate of transformation took off exponentially and gave time for the leadership changes that SECDEF had made and the obvious rewards that would accrue those with the proper vision to achieve traction and ensured SECDEF a justifiable chapter in the book of world hero's vis-à-vis a footnote in history. On that solemn day, we recognized a new enemy, that was in reality an epiphany, that was ubiquitous and global and ushered in a variety of threats that were as challenging to our imaginations as much as to our resources.

So what is "transformation." Let's go to the source for the definition, because if he did not coin the term, he certainly redefined it? In the Monday, 16 September issue of "Transformation Trends", crafted and promulgated by my dear friend Art Cebrowski, for whom the term "warrior" should be reserved, and who resides on the other side of Pluto intellectually; Secretary Rumsfeld is quoted as saying: "I'm frequently asked to describe transformation, and I can say this. Transformation is not a single thing to be trotted out and looked at and inspected. Simply put, transformation is change. It's change in the way we fight, in the way we train, in the way we exercise, but especially it's a change in the way we develop leaders and, most important, in the way all of the services work together."

With that, let's launch into the fray. I would be less than honest, or a friend, if I did not address some of the issues that Herb had intended to cover some of which I actually agree. Imprimis, Herb reminded me that I would be followed by the oracle, Tony Woods, elegantly articulating his masterpiece "Transformation a Mindset." He then hastened to add that his salient point was

that he had concerns that we will not transform DOD, if we apply Risk Management to experimentation. He opined that to continue to work in a risk adverse environment and even risk management is a pipe dream and that for us to transform, experimenters must be allowed to fail, because in an experiment, failure is impossible and an oxymoron. He was to recommend that there be made a formal distinction between Experimentation and Demonstration." This issue has been debated for years and the time has come to put it to rest on Herb's side of the bed.

Permit me to seize this moment to suggest to you that we are at zenith, with the widest aperture of opportunity ever, for transformation with less risk than has been witnessed before on earth, but this aperture will rapidly shrink. We apodictically are the strongest military forces on Earth. In fact, we spend nearly as much on weapons as the remainder of the world combined and frankly could conquer the world if it became necessary. But, we would be motivated by far different reasons than what other nations would aspire. We seek not to build empires, but to create peace, prosperity and freedom. The greatest risk that we face is not to transform. It is an incredibly exciting time. We have supposedly mobile units that are not even transportable. But, we also have a Coast Guard that is rapidly approaching block obsolescence, but under the brilliant leadership of RADM Pat Stillman and the Deep Water Program, it will emerge as the most modern Navy in the world and the second largest.

Herb proceeded to espouse his concern that many in DOD will make token, or marginal, changes to antediluvian systems and ways of doing things and limn it as transformational. As a result, he had trepidation's that a decade hence we would have the same appearance as today. I have an abysmal schism with these concerns. The former concern I am in violent agreement and echo and amplify his concerns, but our military 10 years from today will be very much different and I offer the contrast between Desert Storm and the Afghanistan campaign as evidence to support my position.

Herb also believes that Navy made a grievous mistake in institutionalizing experimentation and moving it to the Naval War College in Newport and that the action was a major setback. Furthermore, he believes that supporting experimentation between John Paul Jones and Mahan lectures requires a logic transplant. I guardedly concur because what it takes to solve real-world problem calls for a wider range and integration of skills than is furnished in discipline orientated textbooks, classes and Ph.D., dissertations.

Never have I been prouder of our military than in Enduring Freedom. Our ineffable warriors went half way around the world and achieved in nine weeks, what the Soviets failed to do in a decade, with the enemy under his belly. Were mistakes made? Indubitably! But, not those made in Desert Storm. Why? Because of our extraordinarily intelligent and educated service personnel, who unhesitatingly and unashamedly, critically analyzed lessons learned and found solutions to the challenges so that they might not be practiced in the future. But, most importantly it is the unique freedom that we enjoy in this great nation to openly debate differences, a society that serves as the reservoir from which only the best are called and privileged to serve. Those so magnificently represented here today. It is our system; it is our people, who permit us to reside in a very much different galaxy than the rest of the world.

Several years ago, I had the honor of addressing the Hellenic Ministry of Defense in Athens, Greece, and whereas I have spent minutes drafting this diatribe, I had spent days crafting my remarks for that occasion and was reasonably proud of my product. It was in all humility a fine speech, but it was wrong for the audience, as they did not capture what I was communicating and it was not a language issue. It occurred to me that they had looked across the Aegean Sea through a straw for so long that they had become badly dated and was a scintillating example of a military that screamed for transformation. This experience convinced me that this country would never be defeated, because of our system and the long continuous line of those who have answered their nation's call, witnessed the evil of war and would never permit this country to atrophy. Transformation is the current prescription.

Having exhausted my knowledge of the message that Herb had wished to deliver, please indulge me as I briefly address another major transformation and one in which I am more familiar. That being the transition from a platform-centric information architecture age to a network-centric model as the crucible of technology churns out one astounding product after another for which to build the infrastructure. The collaborative decision-support systems that will be presented by the quintessential professionals during this conference will accrete I confidently predict to reside on the network, be dynamic and involve most if not all participants on the network, some unknowingly. We have already witnessed major organizational and culture changes and this Network-Centric transformation has just commenced and has not approached terminal velocity. Dr. Pohl's "Major Transformation Imperatives" are a Rembrandt and my envy.

We will witness collaborative decision-support systems being integrated with the cooperative engagement of targets. Whereby a shared common operation picture will allow the optimum shooter in a force to develop and fire the optimum weapon on a target, even thought the shooting unit may not have an onboard detection of the target at the time of weapons launch, mid-course guidance or kill. Cooperative planning, modeling and simulation, rehearsal, execution, and continuous post strike analysis systems will all be integrated in a manner that will mandate parallel and continuous processing of information at every node/module/way-station, with shared information. The traditional linear flow of information in the calculus for 6.5 mach interceptors will become but romantic memories. For ONR, I adroitly invite to your attention that you are still introducing linear information systems.

What network-centric brings to the altar is that any and all information becomes instantaneously a network asset, continuously available to all on the network. Controllers like found in video games will enable faster and easier manipulation of information in multiple dimensions for analysis and provide the ability to predict events, behavior and collaborative environments, visualization and pattern recognition and myriad other capabilities.

All of the services are reorganizing to implement network-centric warfare, but there remain few that have the range and depth to fully envision the full implications or its unfathomable potential. But, it matters little because the transformation will realistically be evolutionary, not revolutionary.

Network-centric warfare is a work in progress and will evolve I confidently predict. Although discussed for some time, it has only recently been fully understood and then by only a few.

Efforts are underway to expand the concept of network-centric warfare from a purely technical world to the operations doctrine domain. Network Centric Warfare is applicable to all levels of warfare and contributes to the coalescence of strategy, operations, and tactics. It derives its powers from the robust integration and coordination of a well-informed, but geographically dispersed force. The sublime 31 August address by the Chairman, Joint Chief of Staff, General Myers, demonstrated a level of understanding, knowledge and appreciation for the power of Network-Centric Warfare by a four star flag officer that would have been merely an illusion in the recent past.

The enabling elements for Network Centric Warfare nourished by collaborative decision support systems are:

- (1) a high performance information grid that is survivable and enduring against the full spectrum of physical and information operations threats;
- (2) integrated sensors capable of generating high levels of battle-space awareness synchronized with military operations;
- (3) value-adding command and control processes; and
- Finally, (4) weapons reach and maneuver with precision and rapid response.

Network Centric Warfare will accrete continuously as the advantages of including an ever increasingly number of platforms with their sensors, or islands of information, to the network, greatly facilitated by the introduction of programmable, wide-band, secure, open architecture communications system. These terminals can be configured for use on ground, airborne or shipboard platforms, can send reliable voice, data and imagery and video simultaneously and will permit automatic routing on the network. These software programmable, multi-band, multi-mode digital radios will provide increased interoperability, flexibility and adaptability to support the full spectrum of varied warfare mission requirement. Because of this new capability, simultaneous networked voice, video, and data operations with low probability of intercept over multiple frequency bands will be realized. These networks will be capable of providing short-to-long range, both terrestrial and satellite communications, information exchange of voice, video, and data, at extraordinarily high data rates.

However, our archaic budgeting and programming processes remain platforms and weapons systems focused. But, there is a growing awareness of this condition and a respect for the vital contribution that Network-Centric Warfare has to offer and that it is a dimension of warfare that will have a galactic effect on how conflicts are resolved. Accordingly, dynamic changes are being made to the acquisition process and I am confident that the right things will result.

We are indeed surrounded by fantastic opportunities brilliantly disguised as unsolvable problems.

Democracy flourishes, freedom rings and America sleeps easier in the knowledge that we have the world's finest warriors, best trained and best equipped. Whenever freedom is threatened, when America's future is on the line there you will find, with the reliability of gravity, the most awesome military force ever assembled ready to respond. They will issue an invitation to the rest of the world to join the fray when they can and leave with they must, but in the event of

regrets, they are prepared to take care of business alone. Transformation will have made a major contribution.

You have honored me by your kind attention and the gift of your time. Thank you! A "thank you" filled with more genuine emotion than the words were ever intended to convey. May your thoughts continued to be cherished in nature, giving in character and reflective in stature and may you experience all the beauty of God's hand and relish in the knowledge that you are a major part of it. May the most that you wish for be the least that you receive and may your worst tomorrow be better than your best yesterday. God bless you and God bless America.

Questions from the audience:

Question: *Admiral, what do you think about the command and control scheme in Tampa as compared to a forward base CINC?*

VAdm Tuttle: Well, not because of technology or the capability, but more in culture than anything. I would want them closer to the area of contact, but I don't want the INTEL officer competing with a soccer game. In other words, the time zone changes… you have to deal with reality and in my estimation it's not the technology, and it's not the latency of the reach-back. It's no longer even a bandwidth, but in my estimation, the person with the ultimate responsibility has to be… I say… closer to the combat… and again, it's primarily in recognition of innate human nature. Whenever they're getting up, you're going to bed or vise versa. And you have the family life and all these things if you're going to adequately support him. The biggest debate that will come out of Afghanistan in my estimation is: Who pulls the lanyard? This debate has been going on since Hannibal came across the Alps, and I've always been mistaken. You talk about risk management, I've been fired more than any military officer in the history of the DoD… because I took risks. You don't agree with that answer… obviously.

Participant: I do agree with your answer, Sir.

Question: *Secretary Marshall's vision was a (vision of) shared perfect knowledge for immaculate warfare. That concerns me, if we're building for that, because history, current events and science all say you'll never have perfect knowledge of a complex system.*

VAdm Tuttle: I say, seek it… relentless pursuit.

Question: *Sir, my concern is if you seek perfect knowledge (you would) build a different system than if you accept uncertainty and build your system with that as part of your going in assumption.*

VAdm Tuttle: No, I don't agree with that at all. First of all, you make a decision even if your (only) 30% solution depends on the situation. You can't escape the fact that everything you know is based upon experience and everything. Every decision you have to make is based on uncertainty. One needs to seek the most perfect knowledge… that doesn't mean that you have to achieve it… but you seek it. And the way you do this is not by using linear systems anymore. Our enemies must not be ourselves. We should not… and we should debate and discuss and disagree, but we should not enter into energy sapping activity. That was Herb's (VAdm Browne) trepidation. Based upon our experience, 39 years in my case… based upon our

experience because that's our heritage… what we were raised with… that was where we were birthed. What I'm trying to communicate here today is that this country (needs to be willing to change). Look at all the fallen empires (that fell because) they refused to change. We have the option. We have the intellect… and I just think… I'm so bullish on this country that we're going to change… even you… (laughter)… and we owe you a great debt of gratitude colonel, even if you're wrong (laughter).

Question: *Sir, we've been focussing on collaborative decision support systems. I'd like to get your views on collaborative decision making at the highest level of the government.*

VAdm Tuttle: Well I'll tell you one thing, I am an apostle, an evangelist and a cheerleader for collaborative planning. And I learned this the hard way in a survival mode in the private sector. I didn't even appreciate it when I was on active duty. The power of collaborative planning is awesome. And it got so in this one company I was in, I could turn out a proposal with about six people in the room and this young lady… she could hear all these things and really say what we old devils meant... and the power of that was stunning to me. Now whether we practice it enough I don't know. But collaborative planning requires one thing, DNA. Trust is the DNA of any relationship. So whoever you have doing the collaborative planning must trust each other… not agree… but they must accept it to their matrix and the calculus of the debate. The power of collaborative planning is more than exponential. As I said (before) I used to put in a proposal practically overnight because we'd bring in five or six people that were educated from different backgrounds… and we would actually put it on (a screen) and scroll it back and forth and take out the variance and come to closure on it… enough of that. Does that answer your question?

(Let me add) another thing… technology enables. And I know that this is a variance for the uniformed people. I wanted my boss to know what in the hell I was doing, but I didn't want to take the time to tell him all the time. I didn't want him running my business. A lot of this came from the missile crisis when President Kennedy was telling the USS Kennedy to do the intercept and the blockade. It also goes back to Vietnam of which I am a product… where Lyndon Johnson was picking out the targets for us to bomb. I am also conditioned by the December strike into Lebanon where the people didn't even know what time of day it was… (and yet) they made a decision so that the Chairman (Joint Chiefs of Staff) could get the word when he landed at Tampa. I don't want any of that. I want them to know.

Question: *General, could you comment on how the enemy drives the need for transformation.*

VAdm Tuttle: Well, striking example for this is terrorism. In 1999, I was at variance with the Defense Science Board which is an awesome, highly intelligent group. How to write that terrorism was the least understood, least studied, (and) most likely to occur (kind of) asymmetrical warfare? Asymmetrical economics… that maggot has cost us far more than 3000 souls. He's cost us a staggering amount and will continue (to do so). However, if you've got two parking tickets, we're going to get you. Because the American people are the greatest problem solving people in the world. The only problem is we keep solving the damn thing after the solution's been found. We just keep (0n)… you know… complaining about the same thing. That's why we need… Jack Sheehan had the best description of this... what the world witnessed from the television with a Coors Light. Whenever they went into Al Queda's headquarters at night… incidentally we've only rented the night, we don't own it. But we went in (over an) unfathomable distance, at night, took out all their INTEL and didn't get a scratch. America's

expectations (in respect to) casualties are unrealistically low. And sadly, wherever it will occur and whenever it is, that we're going to lose people it will shock us again.

Transformation: A State of Mind?

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We live in a period of rapid change. Because we are who we are – Americans surrounded by technology and accustomed to identifying change primarily in terms of its advances – we often view change as either a result of technology or something that is susceptible to examination wholly through technology. That is a mistake. While there can be no denying that technological change is relentless, powerful cultural, social, and economic forces are reshaping the post Cold War world. In comparison with the deadly but predictable symmetry produced by four decades of Cold War, the contemporary global canvas is being seamed together as a "crazy quilt" of regional and cultural clashes in values which are championed by both national and transnational movements. While traditional national militaries such as those in North Korea, Iraq, and Iran remain very visible players, they are the last of a class of international villains whose passing we may regret. Increasingly their place is being usurped by paramilitary, terrorist, and criminal elements who are drafting their own scripts and redefining the use of force and violence. These will be defeated eventually if for no other reason than their ethos of random violence has no lasting basis in the general population. However, defeat could be a long time coming.

A first step in preparing ourselves for this new reality is to recognize certain truths:

- The notion of a traditional gross battlefield involving the clash of large conventional forces a la the Cold War is more likely a fondly remembered dream than a basis for military design.
- There are few valid precedents to the emerging conflicts. Further, our potential opponents have little regard for tradition and process, or the predictability which it may foster.
- We are a product of our own success with coalitions and alliances. As such, we may be the only player on the field who observes traditional "rules" in the coming conflicts.
- When we hear the labels "terrorist" and "criminal" we often picture some sort of thug, a sub-species. We need to unlearn this cultural block; our new enemy is clever, inventive, and committed, and often willing to die for his or her cause.
- We are still searching for the technological "silver bullet". We must critically examine the new situation and our requirements. And we should carefully recognize the capabilities and limits of technology on this new "battlefield".
- The human brain is also a powerful processor. We must develop a new class of intelligence specialists whose bright nimble minds will be worthy successors to Spock.
- Scale and a fascination with process can be fatal to rapid nimble action. Perhaps we need to adopt a nineteenth century British notion and concentrate more on determining the smallest effective package to achieve our objectives.
- There are powerful forces and influences intertwined in the DoD acquisition world and in its most obvious process, the POM. There are powerful forces and influences at work in the international arena whose objective is our destruction. Both are evolving according to wildly different priorities and at opposite velocities. The resulting reality is that

transformation will have to be continuous and uneven. Its progress will be shaped by several tensions; the conflict between advocates of change and entrenched internal institutional and commercial interests; the emergence of difficult new threats and public demand for quick and effective counters; and the tensions stressing our own institutional military mold.

Our Relationship With Technology

I'm in a somewhat uncomfortable position this morning as a man who is involved in the development of information technology, or at least the design of it. With that I'm going to talk about us and our relationship to technology as it affects our response to change. As I speak, I'd like you to think about four things. The first is *generations*. In 1969, like a lot of people, I went to Southeast Asia the first time as a Second Lieutenant to serve in I Corps. In 1974 I went back as a Captain in charge of a joint special operations unit with a different group of people. Actually a different generation. In 1987, around the straits of Malacca and in the Philippines, I participated in a series of small unheralded and little discussed operations with another generation using a new generation of technology. Then in 1997, as Commander of the Marine Corps Warfighting Lab, I served with a young MAGTF commander (Colonel Tom O'Leary) as he deployed and employed an experimental force composed of Marines from this generation. He was faced with a 3,700 square mile battle field, new prototype technology, an experimental training program, a set of clunky collaborative decision support tools. In the end that 800 man force, more than held its own against a fine conventional regiment. The two forces fought on an instrumented battlefield for 10 days and nights, commander against commander, force on force supported by Vice Admiral Herb Browne, Commander Third Fleet. This first major event of the Sea Dragon program led to continuing change in the Marine Corps. I served with *multiple different generations* between 1968 and 1997.

The second thing I'd like to ask you to consider as I make my remarks are the *terms art and science*. War is a conflict, an uneasy combination of art and science. It's continuously uneasy. I'm going to spend a lot of time today talking about the imbalance, perhaps the extreme imbalance that currently exists between the two components in the US Armed Forces and in the defense establishment overall.

The third consideration I'd like you to keep in mind is the word *collaboration*. Admiral Tuttle's remarks captured it far more eloquently than I can, but in fact, it is only through collaboration between intelligent well-trained men and women and new technology that we will achieve transformational change. If collaboration isn't built into the employment concepts and the design for new systems we've missed the boat. There is good reason to think about it from the very beginning. Consider that intuition, conceptualization, and empathy are uniquely human skills while endless memory and detail tracking are skills that belong uniquely to the computer. Design an architecture that joins the strengths of both and the results will be phenomenal.

Finally, the last thing I'd ask you to think about is *roles*. *Generations* and where we are today was the first. The second was the uneasy relationship between *art and science* in war. The third was the *collaborative relationship* required in designing and employing new systems and new concepts, and the last is roles. In our military we have *conservers*, men and women who conserve the military institution. They run the (military), they run the service headquarters, they

run the service education establishments. They conserve and foster the institution. We have the *operators*, the unified combatant commanders and their components, the key forces all over the world, whose single mission is to be ready now. We sometimes forget that when we ask them to host experiments using the operating forces as stages. Remember what their mission is -- ready now. Not in five years.

In addition to *conservers* and *operators* we have the *innovators*, a small group in the defense establishment. Here, the war fighting laboratories are the principal representatives but there are important pockets of innovators in the operating forces.

As I stated at the start, I am a little uncomfortable with what I'm about to say. Uncomfortable because I am a product of the proud and successful establishment that I believe must change. At any rate, as I proceed I'd ask you especially to keep *roles* in mind, because these are a key element of the *institutions* invloved in transformation. We have to put some rigor in the discussion of transformation. There is nothing worse than hearing a young Captain or a young Major or a Lieutenant Commander say we've got to rip the POM apart and fix it, then get Capitol Hill out of acquisition, and let industry suggest the solution . Let's be realistic. None of that is the solution. A long term change in direction has to begin with rigor in the examination of the problem. Then, I think, transformation can in fact be possible.

A New Battlefield

Things have changed. Here are only a few of the comparisons. The battlefield that we inherited from the Cold War (and the battlefield that much of our targeting and many of our systems are still designed for) was a huge battlefield. It was characterized by mass in every respect. Our focus was strategic. In contrast, now it is operational and tactical. In the Cold War we had a single large primary enemy. Now we have enemies all over the world, in every shape, size and color.

Today, in place of gross fires, we're very interested in accuracy and effects, precision. How about *precision intelligence* and *cultural knowledge* as equals with force ratios and order of battle? Previously we had few rules. In fact the only rule was to stop them on the North German border and survive. Today we live on a battlefield governed by rules of engagement (ROE). Previously we had a traditional alliance, NATO, around which all else revolved. Today we have the alliance du jour, the alliance of the moment. Finally, our previous employment focus was on corps and fleet, on the strategic and the high operational level of war.

Arguably, one factor in the collapse of the former USSR was realization of the huge (and growing) technological lead possessed by the west. However, while it served us well then, much of its legacy does not. The negative part of that legacy is expressed in our attitude toward technology and change. *Change is a result of technology. Change can be detected primarily through technology. New technology will solve the problem and we will automatically win.* In other words, the guy with the superior technology will automatically win. These are views that most of us in this room at one time or another have held or have at least unconsciously adopted. They don't serve us well any longer. They ignore many of the parts of the problem that have to do with the *art* of war, which is uniquely human.

Some Conclusions:

My first conclusion is that we have a huge imbalance between the science of war as represented by the current technological focus and the art of war represented by the time, effort, and resources we expend on developing rigorous analysis and decision skills. It's time for the art of war to be ascendant. It's time to concentrate on re-balancing technology with rigorous thinking. We can only do this by improving education, and the training. Our goal has to be a "sea change" in the ability of battle leaders at all levels to analyze and think through the problem, and to intelligently exploit technology to help us solve it. At the moment there is an over-dependence on technology at the expense of clear thinking. War is about two persons who disagree violently and whose wills are opposed. So the target… the immediate targets may be on some battlefield, but in fact, what we're after is to change the other guy's head gasket. Technology must be assigned a subservient role… subservient role to thinking and planning is where I think we're going to have to go. Now think for just a minute… we spent probably hundreds of billions of dollars trying to figure out how to bomb a HUMVEE in the middle of a desert at noon, but we only hit it once out of five times. Imagine trying to identify the attitudes of a group of militant terrorists in an urban environment relative to the threat that they pose. I mean on one side we've got this complex equation that we haven't been successful in solving through technology (i.e., of targeting the 1990s battlefield). And we're still doing a lot of that. And on the other, we've got this contemporary battlefield that has to do with (i.e., the terrorists') motivations, what their culture is, and where they're going, funding sources, state sponsors, and more. Subtlety, invisibility, discretion, and cultural knowledge are some of the characteristics of the battlefield that we're facing. "What is the problem" is always the first question. Let's ask it, and let's answer it.

That leads me to my second conclusion. *Perceptions are paramount.* Above all else warfare is a contest of wills. Future generations of leaders need to be raised in that frame… a conflict of wills. How will that conflict of wills *manifests* itself? Urban terrorism on a horrific scale as we had on 9/11? Waves of popular unrest such as those shaking Pakistan? The suicide bombings of the intefada? All are the manifestations of a conflict of wills. I think future captains and majors will go…must go to war better equipped to spot the conflicts and deal with their manifestations. My guess is that they will be grounded in the culture and thinking of the people among whom they will operate. Future mission analysis and campaign planning will have to be heavily oriented on the discrete, the subtle, and the difficult details of culture and conquest.

We have some unlearning to do Thugs, and other labels get in the way of clear thinking –of analyzing who the enemy is and what he really needs. We can leave those (labels) to journalists and politicians. *It's OK to respect your enemy.* If you don't, you're a fool. It's not OK to underestimate him, or to apply a street label to him to keep you from seeing what his capabilities are. Today in Pakistan, as many of you know, there are a lot of Islamic schools which are often characterized as terrorist cradles. The schools probably are in many respects. What else are they though? It might be a good idea to also understand that these religious schools are the only way many poor families can educate their children. Terrorist cradle? Yes. Popular symbol of a better life? Also yes. It might be important to understand both aspects before you go in to actually do an operation. As we do this more discrete and more difficult targeting of minds, as well as targeting of physical targets, rigorous analysis and sharp decision skills *supported by technology* are essential.

So, onto another conclusion. We may regret the passage of some of the post cold war regimes… strange as that sounds… we may regret it if only because they're obvious and their actions more

predictable. We are moving farther and farther into a far less predictable, far more subtle and far more sophisticated set of battlefields. As we do so we don't want to forget that the other guy is clever, inventive and committed… and probably brave as well.

Tradition and precedent. I know I'm going to tread on toes. Tradition and precedent are invaluable for that group of men that I discussed. You remember I talked about the force employers, the operating forces… and I talked about the innovators. And I talked about the conservors, the men and women and institutions that preserve and sustain the services. The symbols of tradition and precedent are an important part of that. However, I submit that other there are very few lessons from the Civil War that are of much utility on the current battlefield. Formal conflict, large masses of men, industrial warfare, sure Lee's thinking was great (and his understanding that it was a conflict of wills), but that's about as far as you're going to get for parallel. Mobility? Maybe. I'm a student of history and I think that it has lessons. However, the point is that the art hung on the hallway walls in our war colleges is an important indicator of our thinking.

We're cradled in tradition and precedence and there are few close precedents to the emerging conflicts. Now I said, Tony, ask yourself that question. I said, OK let's look at the small wars of the 1930s. The Marine Corps was in Nicaragua and Central America for 13 years. Governed two countries during that period. A lot of people don't realize that. Very few people also know that a Marine Brigadier General led the bonus marchers against Douglas MacArthur in the streets of Washington under President Hoover. So maybe there are some precedents. Let's say that the small wars were a precedent. Really? How many people even knew that the small wars were going on in the United Stares? Hardly anybody. There wasn't any information revolution in the twenties and thirties. The battlefield wasn't public. It wasn't global. Did the people in the country even know the war was going on? Only where it was actually getting hot. So what's the precedent out of the small wars for the current situation? Not much… not with global terrorism and not with criminal connections. Not much when you're not sure how the funding is flowing between people who are growing coca, marketing cocaine, buying guns and unseating governments. In short, not a lot of precedent. So we need to be careful about tradition and precedent. We need to establish the educational foundations for a generation of men and women who will rigorously examine this new global canvas and then exploit technology to assist in dealing with a far more sophisticated and complex battlefield.

The consequences of dominance. Our legions are everywhere and they're unopposable. These are the finest men and women I've seen since 1968 in combat and otherwise. '68, '75, '87… years in which I served with young Americans… and again in Hunter Warrior with Colonel O'Leary, probably as close as you get short of the real thing. And yet, getting here we've created a worldwide network of very large staffs… frequently with an inward focus. How many of you have seen a very large command staff or another headquarters that is almost wholly focused on itself and its concerns? All of us. It happens. It's human. Huge staffs. And part of it, of course, is simply maintaining the appearance of power, which is important. But it can get in the way of our focus… and it can lead to the supremacy of process and planning over substance. Admiral Tuttle mentioned it several times this moring. We could process ourselves right into the ground and plan ourselves right through it. That doesn't mean we can *execute*. What is really becoming important in terms of the information technology that supports the operating forces, is subtlety, agility and discrete focused support. This frequently can get submerged in the consequences of dominance… large headquarters and huge staffs.

As the Empire retreated, the last thing the British pulled out were general officers and bands. It's true. That's how they retreated… that's how they rolled up the empire. They understood the use, the economical power of symbols. We may need to take that lesson in another respect, I think. Maybe what we should be concentrating on is using information technology to support employing the smallest force that can do the job at acceptable risk. That could lead to a whole new set of tactics and concepts in warfare including an emphasis on the importance of conceptual thinking rather than instant dependence upon technology and "templates". It is rigorous conceptual thinking and decision skills supported and fostered by renewed training, education that will keep our legions in the dominant position they occupy today. But what about technology you ask? Does anybody here seriously think that this technological juggernaut we've got going is even going to slow down? It's not. On the other hand, because the technology part is so much more dominant, involves so much more money, and (generates) so much more visible interest, it's going to take some real effort to move the *art* part of the art and science relationship forward.
In 1990 when I was serving at CINCPAC, I went in to see Admiral Larson and I said: "Admiral, the Marine Corps owns exercises, the Navy owns exercises, the Air Force owns exercises, and the Army owns exercises… and you don't own any. The CINCPAC staff doesn't write the objectives and define the purpose of a single exercise in the Pacific." Well, we went through that for a couple of days and he said, "You're right." I said, "Why don't we build an exercise to test a joint task force, Admiral, and an exercise that tests power projection at a joint level?" And he did. The point is that the design of experiments and control of their execution must be closely held. Otherwise we all to slip back to our familiar zones. The design is critical. But control… why is control so important? Because as Colonel O'Leary and his guys found out, and as we Marines found out in Hunter Warrior during 10 days and nights of free flow play, you have to be able to win *and lose* without interference… otherwise you don't find out what really works.

So if we're going to get past demonstration, we're going to need some top-down leadership. And then I think we're going to have to create some kind of an upward track that allows new thinking to be rewarded… and we're going to have to connect it to promotions and resources because those are the sources of power in the establishment. Now I know this probably doesn't sit all that well, wouldn't it be terrific if annually OSD sponsored a "present and defend" blue ribbon forum where new military concepts… that did not, by the way, go through the chain of command or the service educational hierarchy but went straight to OSD for review… would be presented and defended in front of a jury? I've done this a couple of times with the British in NATO forums… ruthless and rigorous forums in which to wring out a concept. Its really a great way to find out if there's really something there. And the two or three men or women who come out on top could be submitted by the Secretary of Defense for accelerated promotion. Why not? We promote program managers every day… even those with failed programs. How about promoting good thinking? And then, tie it to resources. If something is good enough, then OSD should have the capability to commit some resources to it. Kind of what Admiral Cebrowski is doing now for transformation… to make it happen. The art part of the art and science of war is going to have to receive the same kind of resourcing and process support that the science part is receiving. I am afraid that right now the science piece has sucked most of the oxygen out the room.

As we move through this business of transformation, we've got to remember who we're talking to. We forget this all the time. If you're in the operating forces, how long is your horizon? A year? Eighteen months, maximum. And you're working 18-hour days and most weekends

already. They are busy out there. So if I walk in and propose a five-year experiment… an experiment that's going to bring new capabilities maybe in five years to an operating force commander, what am I doing? I'm violating his planning and visualization horizon. He is not going to be there when it matures, and secondly that's not his primary responsibility. So what am I saying? Am I suggesting that we shouldn't be conducting experiments in the operating forces? No I'm not saying that. But I am saying that we absolutely have to recognize that experimentation is not the primary mission of the operating forces. Their mission is readiness right now. And they've got a huge number of tasks for which they must train already. We need to keep that in mind when we talk about planning and executing experiments. Frequently the pressures in the operating forces reduce experiments to demonstrations. But I submit to you that demonstrations are often a waste of energy. At any rate, as we design these notions of how to improve ourselves for the emerging battlefield we need to carefully consider who we're talking to and what their concerns and time horizons really are.

To summarize, we face an overbalance toward warfare as a science; we face an over-reliance on technology at the expense of clear thinking and analyic skills; and, we face an over-emphasis on tradition, evolution and precedence at the expense of a better understanding of the contemporary world situation. Interesting isn't it? What a strange trio. An over-reliance on science and technology and an over-emphasis on tradition and precedent? How do you put those bed fellows together? Well, that's pretty much where we are. Meanwhile, things are evolving at wildly different rates of evolution and for wildly different reasons. So, what are we faced with? Well first of all, we're just going to have to recognize that an awful lot of the heritage we've got comes from that cold war battlefield presented in the very first slide. We're all infected with Cold War thinkng because that's where we were raised, and it may not be very suitable for what we're getting into. Rather than continue to build cold war concepts and systems just because we know how to do it we should be building a whole new class of officers and NCOs, cultural specialists, and discrete subtle collaborative decision support that complements rigorously trained minds. In short order we'll be using the tools we're going to give them to advise commanders in a manner that looks closely resembles Spock on the bridge of the Enterprise. Maybe that's the vision we ought to have. And let's not forget industry. Industry is not an automatic ally of transformation. There's more profit in selling the current than there is in stepping out and gambling on the future. So we need to think about this because if we don't, we're going to let those generations down that are out there in the operating forces "doing it". And we're going to let ourselves down and our country as well.

Transformation Toward What? Looking at Change

Pre 1990	***Versus*** **Post 1990**
• Global battlefield	• Regional & local battlefields
• Strategic focus	• Operational and tactical
• Large primary enemy	• Multiple different foes
• Mass and volume	• Accuracy & effects
• Gross fires	• Precision targets/targeting
• Few rules	• ROE focus
• Traditional alliance	• Shifting allies
• Focus on formations	• Small unit, the individual

Slide 1

Traditional Focus is a Focus on the Science & Technology of War, not the Art

View #1 : Change can be detected primarily with technology

View #2 : Change occurs largely as the result of technology

View #3 : Change can be dealt with primarily with improved or new technology

View #4 : Change is susceptible to examination primarily through technology.

View #5 : Superior technology automatically grants the advantage

Slide 2

Conclusion # 1

The contemporary global canvas is a "crazy quilt" of regional and cultural clashes in values championed by local, national and transnational movements. Because we are who we are – Americans surrounded by technology and accustomed to identifying change primarily in terms of its advances – we often view change as either a result of technology or something that is susceptible to examination primarily through technology. That is a mistake. Powerful cultural, social, and economic forces are reshaping the post Cold War world. In the future force, technology will be employed collaboratively and selectively by men and women who understand that the art of war is ascendant in the new era.

Slide 3

The Art of War and the Contemporary Battlefield

- **A violent clash of wills, with**
- **A political, cultural, and/or economic basis,**
- **Where values and perceptions are the keys**
- **Exploiting technology as appropriate**

Slide 4

Conclusion #2

We must strengthen the capabilities of a new generation of leaders at all levels to view warfare as a contest of wills in which perceptions are paramount. Inasmuch as perceptions and behavior are heavily culturally molded, understanding the foe's cultural frame will be a key component in future mission analyses and campaign plans.

Slide 5

Cultural Blocks and Labels are for Journalists

- Terrorists as thugs, or
- Suicide bombers as heroes.
- Islamic schools as terror cradles, or
- Religious schools as education and steps to improving life.

Slide 6

Conclusion #3

Traditional 20th century militaries such as those in North Korea, Iraq, and Iran remain very visible players. However, these may be the last of a class of international villains whose passing we could regret. Increasingly their place is being usurped by para-military, non-state, and criminal elements who are drafting their own scripts and redefining the use of force and violence. When we hear labels such as "terrorist" and "thug" we often picture some sort of sub-species. Few subspecies produce an enemy who is clever, inventive, and committed, and often willing to die for his or her cause. Defeating them demands understanding and respecting what they are.

Slide 7

Tradition and Precedent

- Positive conservors for the institution and symbols within the education and training institutions.
- But--can act as a negative influence in an era with few close historical precedents.
- Consider the Civil War and then review the more obvious lessons of scale, the importance of process, uniformity, fires, and even chivalry.

Slide 8

Conclusion #4

As a military, we are cradled in tradition and precedent. In contrast, there are few valid precedents to the emerging conflicts. Further, our potential opponents have little regard for tradition and process, or the predictability which it may foster. The notion of a traditional battlefield involving conventional forces a la the Cold War is more likely a fondly remembered dream than a contemporary basis for military design.

Slide 9

Consequences of Dominance

- **The penalties of huge staffs**
- **The dangers of inward focus**
- **The supremacy of process and planning**
- **The loss of subtlety and agility**

Slide 10

Conclusion #5

It has been said that when Britain retreated from empire, the last military elements to leave were bands and generals. Scale and/or a fascination with process can both be fatal to rapid nimble execution. When the culture in large staffs focuses on these, it can stifle the growth of individual and small unit initiative early in careers. Perhaps we need to adopt a nineteenth century British notion and concentrate on determining the smallest effective package to achieve our objectives.

Slide 11

The Program

- **"…like a super tanker".**
- **More than just resistant to change**
- **Major component in sustaining our long over-focus on technology and the science of war**
- **And necessary.**
- **The pre WWII German example**

Slide 12

Conclusion #6

A strong means to surface and evaluate new concepts and supporting new technology is vital. Establishing an OSD capability to design, control, and assess experimentation may provide the means to surface unwelcome new improvements and to insure follow-up resources. An annual blue ribbon OSD "Present and Defend" competition for new concepts (independent of service schools) would further strengthen a renewed focus on the art of war. Rewarding brilliance and unconventional efforts in these areas through individual promotion and assignment of development resources would link this emphasis on flexible thinking and the art of war (and supporting technology) to the sources of power (and change) represented by the POM and the service promotion processes.

Slide 13

Understanding Players and Their Focus Horizons

- The responsibility of CINC(s) and Operating forces is readiness now and a year or two out.
- Experimental agencies may focus as far as five years in the future.
- The program and SYSCOMs focus as much as nine years out.
- Assigning responsibility for a program maturing five years out to the operating forces contradicts their focus of effort.

Slide 14

Conclusion

Not surprisingly, there is a collection of powerful conservative forces in the DoD acquisition world , on the hill, in industry, and in the service establishments. Collectively these create an over-balance toward warfare as science, an over reliance on technology, and an over emphasis on tradition, evolution, and precedent. There is another set of powerful forces and influences at work in the international arena whose objective is our national destruction. Often these forces have little to do with advanced technology but rather are rooted in cultural factors. Both of these sets of forces are evolving according to wildly different priorities. The resulting reality is that our transformation from a cold war mold to a contemporary one will be continuous and uneven. Its progress will be shaped by the conflict between entrenched institutional and commercial interests, the need to effectively counter emerging global threats, and our strong military culture. It is unlikely to be timely unless given "top down" leadership.

Slide 15

The Littoral Combat Future Naval Capability (FNC) Program

Col. Thomas O'Leary (USMC Ret)
Program Manager
Office of Naval Research

The mission of the Office of Naval Research (ONR) is to provide the science and technological base that expands the technological superiority of the Navy and Marine Corps forces at a reduced cost (Slide 1). And it does do that. But the key to the whole thing is getting that technology into the hands of Sailors and Marines.

Now as shown in Slide 2, this is what we traditionally look at within the Navy and Marine Corps… you can also apply this to the Army, the Air Force, the Coast Guard, and any service. You have the current force, the legacy force as it is sometimes called. You have the acquisition community that's working on the next force, and then you have science and technology that's working on the force after next. And what you hear a lot about when you talk of transformation… and this is what I've come to understand to be the myth of transformation after having been involved in transformation since 1995, is how do we get the legacy force to the objective force to the transformed force? And the thing that you have to realize is that you will never reach a transformed force, because the transformed force eventually becomes the legacy force. So, it's a continuous process that's continually transforming the operational force, be it the acquisition community or the science and technology community. You never reach this mythical objective of the transformed force.

What is Future Naval Capabilities or FNC (Slide 3). FNCs are intended to be a process to align and partner requirements, acquisitions, science and technology, and the S&T (Science and Technology) investment to deliver the top priorities for those that need to be transitioned. In other words, to take the very best ideas in technology and ***quickly*** get them into the hands of Sailors and Marines and operators. Now, ***quickly*** is a nice word, but what does ***quickly*** mean? The first time I heard about collaborative agents was in 1995. I can tell that I just put out a BAA and received 65 proposals in which people were proposing collaborative agents as if they were a new idea. So what is ***quickly***? Certainly not months… but should they be?

Why did ONR go to Future Naval Capabilities programs? Well, as you can read in Slide 4, science and technology and good ideas have traditionally been… and you can include Advanced Concept Technology Demonstrations (ACTDs), a field of dreams. The concept was, if you build it, they will come. If you do something really good, it will be so compelling it will force a change within the bureaucracy within the system. And this has happened at times. A couple of notable examples are GPS (Global Positioning System) and JDAB. Those were so revolutionary they caused services to change their TTPs (Tactics, Techniques and Procedures), but those are the exceptions. Unfortunately, what usually happens are two things. One, there are a lot of good ideas, but they're below the noise level. You have people working on something in one university, on something else at another university, and something else again in industry, and there's no way to bring this desperate initiatives together and form a critical mass. You get a spike (FNC) that Dr. Pohl was talking about. How do you get them into a spike? So, the first

problem is to be able to take all these good ideas and connect them… because we're really the collaborative agents.

That's really good, but that's only a piece of it. Where do you get the data for the collaborative agents? Somebody else is working on that. And then, how do you establish the part to link the data sources for the collaborative agents and the decisions that come out of the collaborative agents to the warfighter that needs them? So, there are many good ideas and they all have to be pulled together in a FNC spike. So that was the first problem that FNCs were set up to solve.

The second thing is this valley of death… and this is one of the problems that you run into with a lot of advanced technology demonstrations. You go out, and you take emerging, maturing technologies and bring them together with an operational concept. Then you demonstrate the concept and you get a positive reaction out of the leadership and they say, "we want that". And everybody knows that the required funding works on a two-year cycle. So you bring it in now, and they're talking about FY05 and FY06. So they're saying this is great, let's get it into the cycle. Well, by the time that money shows up they say, you know, that really is three-year-old technology, we might as well start over again. So, you do another two years of science and technology. What ends up happening is that the two years that you invested up front with industry, with academia, and with the services' S&T efforts, is lost. Then you go out again and wait another two years to get money, and so on. Finally, everybody turns around and says, how come the acquisitions community can't get their act together and give us something.

The FNC program is designed to move us away from this valley of death by linking requirements, technologists, acquisition, and resources together. The concept is that when we take an idea and build it into a spike, it has a clear transition intention… to fast track it into a program of record or to help develop a program of record.

Now, what are the characteristics of FNC spikes (Slide 5)? In other words, how do you know what to work on? Well, you go with the main priorities. However, there are a lot of priorities, and I'm going to talk to you a little bit later about how we in the Littoral Combat FNC went about identifying our priorities. that. From a general point of view: it has to have significant technology options; a good budget which means enough money to do what needs to be done; and, definitive milestones. There have to concrete deliverables that are well defined in the demonstration. Experiments will and should take place, but when the day is done you have to demonstrate that capability to be able to get it into a program of record. Because it is now expected to go to the forces, such as the fleet and the fleet Marine Corps. It has to culminate in a firm transition… that's what it is all about. The reason why we exist is to take this technology and put it in the hands of the warfighter.

Now, how do you select the right technology (Slide 6)? Essentially, you are closing a gap by signing up to deliver a product and demonstrate it within the timeframe of a five-year window. I am currently working in a FY03 to FY07 window… that's what I'm focused on. Within ONR you also have the discovery and innovation program that is working beyond that window, and I take things from that program into the FNC. I can also take things out of academia and industry into the program, and I can also go out to a program manager, or to an acquisition program manager if he or she is having a problem and help to fix that problem. But there are also a couple of other key issues. First, you have to have a commitment to transition… we don't spend money unless we know where it's going. Second, it has to be affordable… there are a lot of great and elegant solutions out there, but the Navy and the Marine Corps may not be able to afford the solution and would never be able to field it.

There are 12 FNCs (Slide 7) that have been developed. And again, these aren't forever. These are designed to go and to look at some specific problems, deliver the required capabilities to the acquisition community, and get them into the fleet. Now, how serious is ONR about this program? Pretty serious. They put over a third of their 1.6 billion dollar budget into the FNC programs. That is a major shift in any organization to take a third of all of its resources, including people, and put them into this effort.

The FNC that I am currently working on is the Littoral Combat FNC… and in some ways I'm kind of an experiment. Initially, the FNCs were set up to focus on naval operations or the naval portion of the joint campaign. However, there's a lot more to littoral combat. So, they made the decision to do some rearranging and add two new FNCs. One is the Electric Ship and Combat Vehicle program and the other one is the Littoral Combat and Power Projection program. Now as I said, they did a little bit of an experiment here, because rather than asking one of their highly accomplished and qualified science and technology program managers to take over this FNC, they decided to bring in someone who had an operations background. Of course they took care to reduce the risk, by putting a whole team of accomplished S&T people on the program with me. However, my background is operations and not science and technology, and the reason I was assigned to manage this FNC was to make sure that the science and technology would be concept based… that it would start out with a solid base of expeditionary maneuver warfare.

At the beginning we were considered to be just another vertical hatch among the other 11 FNCs (Slide 9). However, as we started looking at our role and game plan in more detail, we began to ask ourselves: Don't we want to have knowledge superiority insurance? Aren't we concerned about the mine threats? Don't we need precision strike capabilities? Doesn't littoral combat really cut across many areas? And then there was this other point of view that the Littoral Combat FNC is intended to be that Marine Corps FNC. When we looked at this I said, you know, it's not really a Marine FNC at all, it's the Naval FNC that cuts across all of these areas. It's where the future fight is and it's a Naval concern. So we're a little bit different in that we cut across all of the FNCs. This requires us to work hand in hand with the other FNCs, while we try to focus on some specific gaps… particularly is they relate to the Ship To Objective Maneuver (STOM) piece of naval expeditionary maneuver warfare (Slide 10).

Now, we had to find a starting point to be able to do this because this is emerging and we needed to be able to provide a common vision to our partners in industry and also to academia… so that they would understand what we were talking about. This meant working hand in hand with doctrine, concepts, and requirements that Marine Corps Combat Development Command (MCCDC) and the Navy Warfare Development Command (NWDC) have a primary responsibility for. You see in the slide (Slide 10) what we're trying to do in our near term objective for STOM within the context of naval expeditionary maneuver warfare. Eventually we want to go to completely free operations in a disbursed and non-linear battlefield… but we're not yet ready. Collaborative agents are one of the tools that are going to allow us to do that in the future, where you can do dynamic planning and adaptive execution continuously. They will get us there in the long term. In the interim we're focusing on what is doable in the near term: the force that will be delivered in 20 tanks; the ability to identify where the threats are; the information that is required to decide what needs to be done and convey that to the appropriate executor… sailor and marine, so that they can maneuver around the threat and get to the objective. And that's a hard thing when you think about it.

You might say, well is this future amphibious operations? Well, kind of but not really. It does derive from past amphibious operations when you think about it. In World War II or in the 1930s when it was developed, amphibious operations was about obtaining ensured access in order to be able to then take possession of the site of operations. Once you had your 'iron mountain' and your beach head, then you could support sustained operation. When you look at naval expeditionary maneuver warfare, and particularly the idea of seabasing, it's the future of assured access in the global strategic environment of the future. It is a legacy of amphibious operations, but it's different because in amphibious operations you selected the amphibious objective, the landing force objectives, and the amphibious objective area. You did all of this and it was very linear, and then you put your head down and you went. There was very little dynamic planning. It's continually going onward… as you plan you gain more situational awareness… as you execute you gain more information and the plan can be updated. As the plan is updated, commanders are able to convey better decisions to those who are executing. The executors then also have to be able to adapt, and eventually get to what Admiral Cebrowski calls self-synchronization… which would be something well beyond the 2010 force. But it's with the idea that you will be able to do dynamic planning and adaptive execution that collaborative agents really come into play.

Our goal is to support the development of naval expeditionary maneuver warfare and enhance the ability of the Navy and Marine Corps team as part of a joint force, to ensure assured access and sustained operations in the littoral. In this regard we have identified four enabling capabilities in which to invest S&T resources. The first is ISR (Intelligence, Surveillance and Reconnaissance) for the amphibious force, next is fires to the MAGTAF, then maneuver and littorals, and finally task force command and control.

Perhaps we were fortunate in that we had to start essentially with a blank sheet of paper. Most of our fellow FNCs found that a tremendous amount of work had already been being done in their area by ONR. Now you can sit there and say, boy, they was really lucky, or you could also say they didn't have the advantage of starting with a blank sheet of paper. One of the problems with having to start with a blank sheet of paper, is that you get judged to some degree on how fast you're able to expend money… and not necessarily on what you're doing with the money. So, part of the problem is that you have to get a program going. You have to start executing almost immediately and it's kind of like the chicken and the egg… well, I have to know what I want to do before I can execute… but they want me to execute before they'll give me the money to know what I want to do, and so on. So we came up with a dual track program. We started executing with the initial money that came out of the program budget decision by going to the acquisitions community, going to the Marine Corps Warfighting Laboratory, and the core programs within ONR, to find on-going programs that were getting ready to mature and that we might be able to help push across the goal line. At the same time, we started our longer term effort which began with front-end analysis, war gaming, and so on, to develop our goal and our enabling capabilities, to identify our spike and help to shape our broad agency announcement process that went out to industry, and to bring back what came from industry, academia and the labs through the broad agency announcement process.

Now, just to go over a couple of things in regard to our four enabling capabilities:

> The first one is ISR for the amphibious force (Slide 15) and our guidance was, look at the element level in the MAGTF because the joint commander is getting a lot of information… we need to get something down to the tier one, tier two… UAVs for

example. We thought about this and said, OK that sounds pretty good… but really, why are we doing this? Because it's important to get data and be able to feed that data to the commanders and their staff so they can make decisions… commanders at all levels. So ISR really is about getting the best and most timely and most accurate information that you can. OK, well that has to do with command and control.

Well, the next one is expeditionary fires support (Slide 16). There were two areas that we focused on: the gap between the lightweight 155 and the 81; and, network fires, which came directly out of our war game.

The third one is MAGTF maneuvers in the littorals (Slide 17). We have a lot of new things coming into the Marine Corps, such as the AAAV, the V22, and all of these things coming in with a new family of amphibious ships. But again, what drives maneuver? Is it the ability to know where the threat is, so as to be able to maneuver around it? How do you get that information, how do you convey that as information to the decision makers, how do you present it to the decision makers so the decision makers can make timely decisions, and then how does the decision maker get that down to the executor… and how do you coordinate the execution by the executors so that it is appropriately deconflicted. This is something that aviation has done a good job with, and we use that as a model. As we started to study this in more detail we came back with the conclusion that its all about commanding and controlling maneuver, and that brought us back to command and control again… even though it is maneuver-specific.

And then for the last enabling capability we finally got into command and control (Slide 18). The ability to provide command and control at the MAGTF level… to be able to do the job that the MAGTF commander needs to do. However, it really all gets back to being able to provide timely and accurate information to better enable decisions, to better transmit those decisions, and to better coordinate the action by the executor that results from those decisions. Needless to say I can't go into the reasons, but out of those 65 BAA proposal that we received, how many of them do you think had a piece in them on collaborative agent technologies? And it was at that time that I was glad that I sat through those lectures on collaborative agents out at Cal Poly so I would have an idea of what was going on… so thank you Dr. Pohl for tutoring me in that.

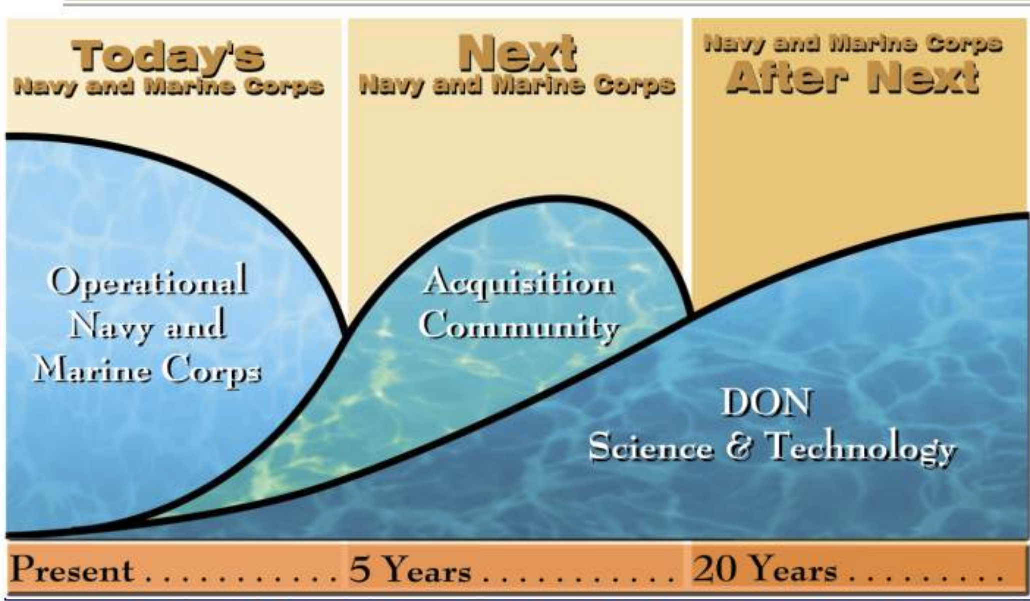
But the point is, if we are going to get to where we're going, collaborative agents and decision making, is at the heart of it. If it's a fire problem… when you peel it back it gets to the decision making… and collaborative agents are going to help enable that maneuver… the same thing and certainly command and control.

ONR Mission

To provide the scientific and technological base that maintains and expands the technological superiority of the Navy and Marine Corps forces at reduced cost.

Slide 1

Concepts:Toward the Naval Services-After Next



Slide 2

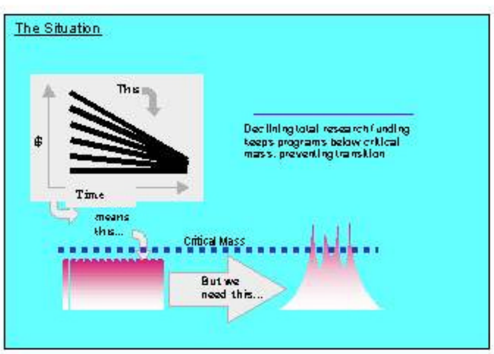
Future Naval Capabilities

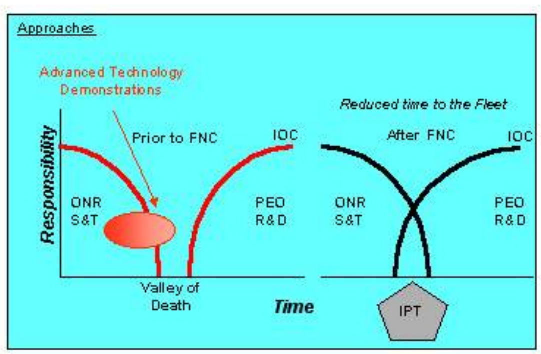
- What are Future Naval Capabilities (FNCs)?
  - A process to align and partner the Requirements, Acquisition and S&T communities to focus S&T investments to deliver and transition priority Naval capabilities within the FYDP

Slide 3

Why FNC Programs ?

- Under Secretary of Defense for Acquisition, Technology & Logistics "Directs" Reduction in Acquisition Time
- Naval S&T is actively engaged to enable the rapid transition of mature technologies to product developers.
- Future Naval Capabilities solve the existing S&T acquisition "Valley of Death" by partnering with Acquisition Managers.
- Future Naval Capabilities focus S&T funding on transitionable products.





Slide 4

FNC Spike Characteristics

S&T Investment Response to a DoN Top Priority Capability That:

- Provides Significant Technology Options and Operating Concepts for the DoN Capability
- Has a Significant Budget
- Has Definite Milestones & Objectives
- Has Concrete Deliverables and a Finite End State
- Executes Well Defined Demonstrations
- Culminates in Firm Transitions

Slide 5

FNC Project Selection Criteria

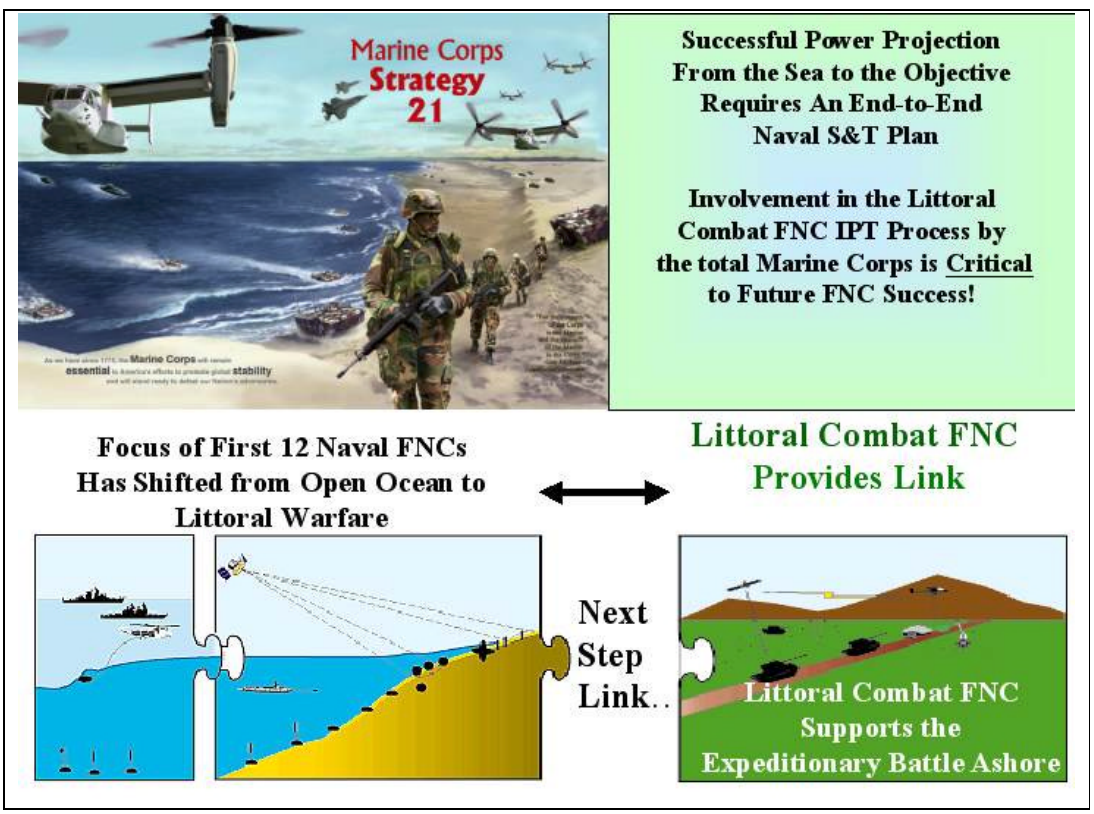
- The degree to which it closes a defined capability gap and the warfighting priority of closing that gap
- The ability to deliver the product and demo it within the FNC window of time
- The commitment to transition
- The affordability (cost and opportunity cost) of the project in a capped FNC budget

Slide 6

Future Naval Capabilities

- Organic Mine Countermeasures
- Knowledge Superiority and Assurance
- Time Critical Strike
- Autonomous Operations
- Littoral Antisubmarine Warfare
- Total Ownership Cost Reduction
- Missile Defense
- Platform Protection
- Warfighter Protection
- Capable Manpower
- Littoral Combat and Power Projection
- Electric Ships and Combat Vehicles

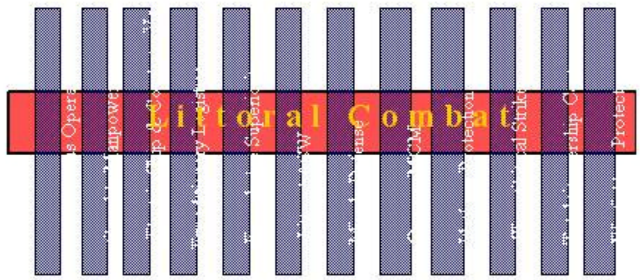
Slide 7



Slide 8

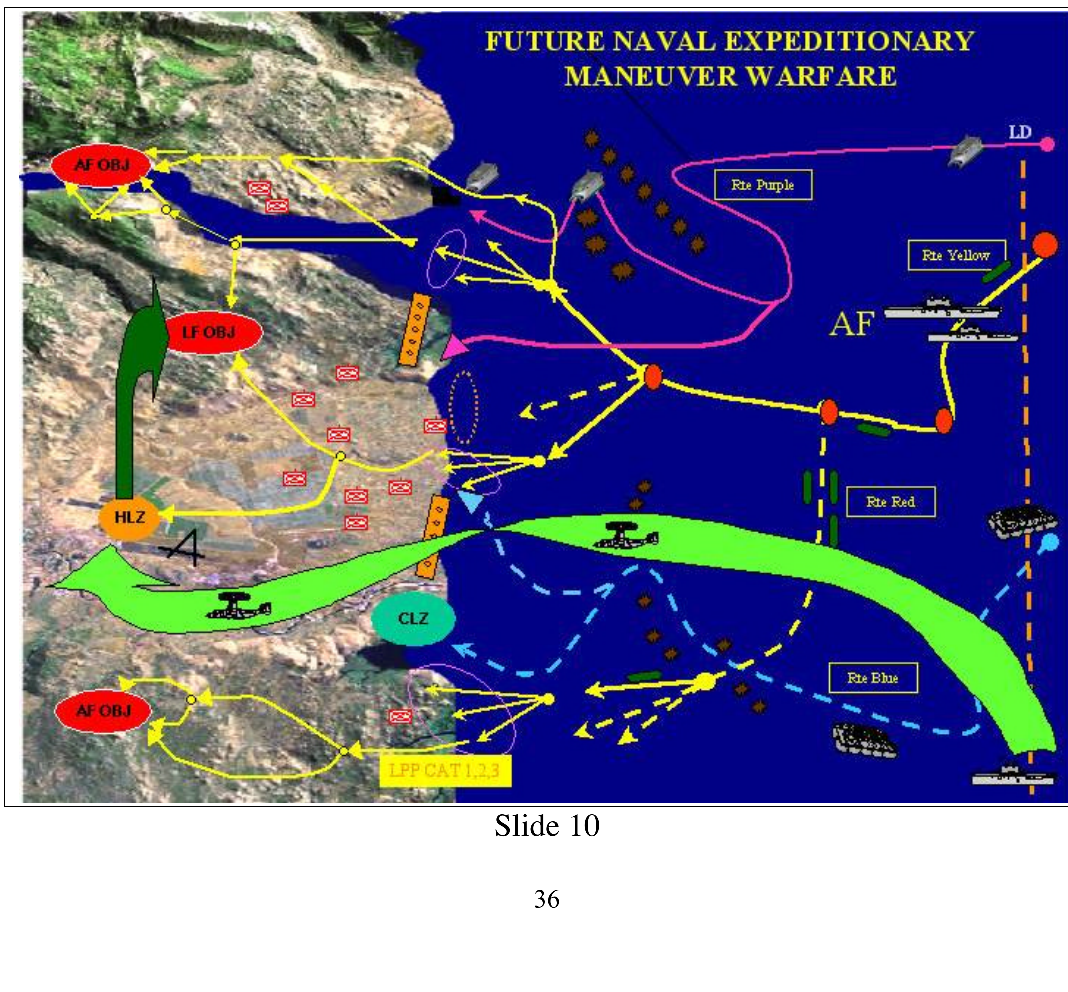
LC FNC Interfaces

Littoral Combat FNC cuts across other FNCs



Littoral Combat is an expansive warfighting problem set
Littoral Combat is not a "Green" only concern
Littoral Combat is a Naval concern - It is where the future fight is

Slide 9



Slide 10

LC FNC Goal and EC's

- Goal: ***Support the development of Naval Expeditionary Maneuver Warfare via the application of technologies which enhance the ability of the Navy-Marine Corps team to achieve assured access and sustained operations in the littorals as the naval portion of a joint campaign.***
  - **EC #1 - Expeditionary ISR for the Amphibious Force (AF)**
  - **EC #2 –Expeditionary Fires Support for the MAGTF**
  - **EC #3 –MAGTF Maneuver in the Littorals**
  - **EC #4 –Expeditionary Task Force Command & Control in the Littorals**

Slide 11

Littoral Combat FNC
IPT Membership

Requirements
MGen C. Stanley, MCCDC Chair
MGen J. Battaglini, N75
Co-Chair

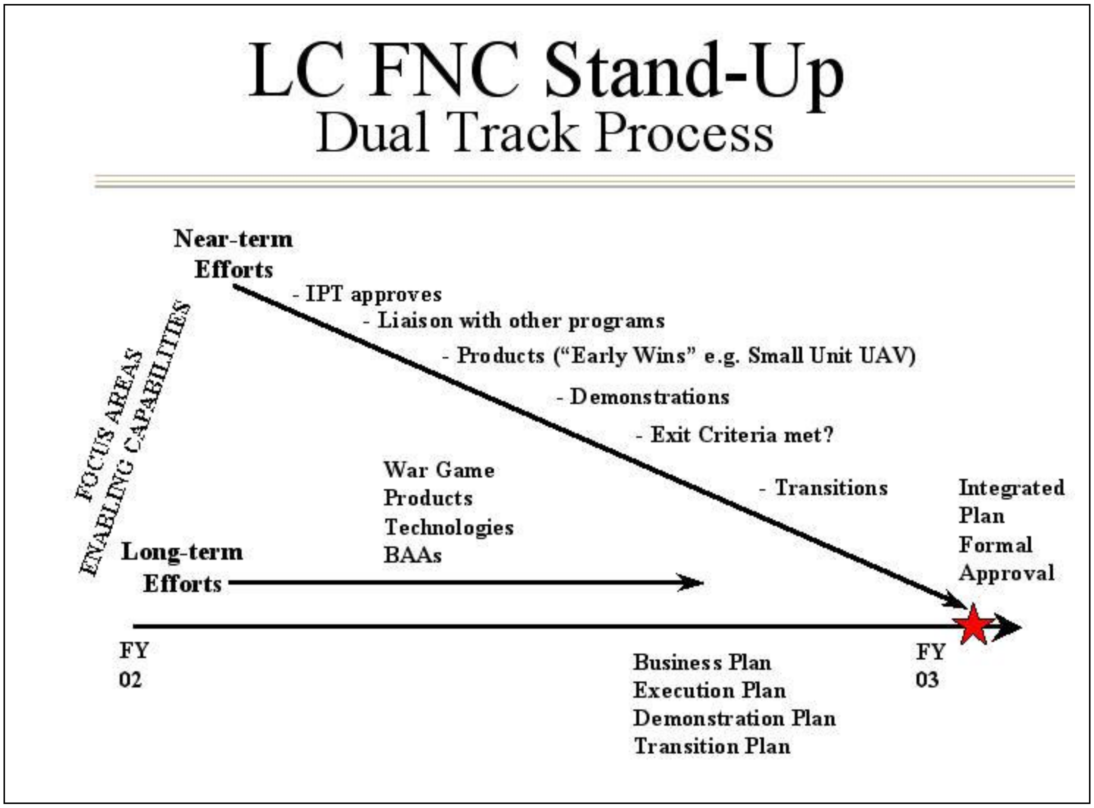
Acquisition
BGen W. Catto,
MCSC

Execution
Mr F. Belen,
ONR 35

Resources
BGen (Sel) J. Paxton, P&R
Mr. Robert Smith, N911

Fleet/Forces
TBD

Slide 12



Slide 13

Littoral Combat Gaming and Analysis Effort

- **April**
  - Expeditionary Maneuver War Game (1-4 April) ***Complete***
  - Technologists Panel (30 April) ***Complete***
- **July/August**
  - Publish Broad Agency Announcement (BAA) ***Complete***
  - Translate Industry/Government Lab White Papers into advanced capabilities that can be played in a technology insertion game
- **September**
  - Technology Insertion Game (24-26 September)

Slide 14

Littoral Combat FNC
Enabling Capabilities

- **Enabling Capability #1 - ISR for the Amphibious Force (AF)**
- **IPT Guidance – Focus on ISR at the Element Level of the MAGTF**
- **Capability Gaps to be Addressed**
  - Provide to elements of a MAGTF autonomous and semi-autonomous ISR capabilities that are locally tasked and controlled.
  - Enhance the ability of MAGTF organic ISR assets to populate the AF database and provide the AF Commander with a higher fidelity Common Operational Picture of the MAGTF Battlespace.

Slide 15

Littoral Combat FNC
Enabling Capabilities (con't)

- **Enabling Capability #2 –Expeditionary Fires Support for the MAGTF**
- **IPT Guidance – Focus on Expeditionary Fires at the Element Level of the MAGTF**
- **Capability Gaps to be Addressed**
  - Provide capabilities that are organic to elements of the MAGTF that support immediate, time critical, destructive, neutralization, or suppressive fires on an extended dispersed battlefield.
  - Provide a "necked-down" family of munitions and smart fuses that support the capabilities required by MAGTF elements, while reducing the munitions logistics burden.
  - Provide capability for suppressive and neutralizing fires to enable support of AF VSW Mine Counter Measure operations (40' to the high water mark) and prevent re-seeding of mines.

Slide 16

Littoral Combat FNC
Enabling Capabilities (con't)

- Enabling Capability #3 –MAGTF Maneuver in the littorals.
- IPT Guidance – Focus on Maneuver at the MAGTF element level.
- Capability Gaps to be Addressed
  - Enhance the mobility of surface landed MAGTF elements by providing land mine and obstacle breaching capabilities from the beach exit zone to objective.
  - Enhance the ability of surface assault elements to maneuver from very shallow water (40' to the high water mark) through beach egress.
  - Enhance the ability of vertical assault forces to move crew served weapons and logistics once landed. Decrease the logistical requirements of MAGTF elements ashore in four critical areas: fuel, water, batteries, and ammunition.

Slide 17

Littoral Combat FNC
Enabling Capabilities (con't)

- Enabling Capability #4 – Command and Control in the littorals
- IPT Guidance – Focus on Command and Control at the MAGTF level.
- Gaps to be Addressed
  - Provide the MAGTF Commander with a Command and Control capability that is robust enough to command all MAGTF elements and provides a level of connectivity up to higher headquarters that will allow him to serve as commander of a Joint Task Force Forward, if required.
  - Enhance the ability of MAGTF C2 architecture to leverage gateway capabilities of Navy platforms.

Slide 18

Littoral Combat FNC
Program Management Team

- **Program Manager - Mr. Tom O'Leary**
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- **Deputy Program Manager- Mr. Barry Blumenthal**
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- **Transition Manager- Mr. Jim McGillicuddy**
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- **Demonstration Manager-Mr. John Garvin**
  (PH: 703-696-4181; email, garvinj@onr.navy.mil)

Slide 19

The Joint Task Force Wide Area Relay Network (JTF WARNET)

Raymond Cole, Jr.
JTF Warnet Technical Manager
Office of Naval Research

Good afternoon. This started in 1997 and it focused on several areas and I'll cover those in a little more detail as I talk about JTF Warnet. However, it really culminated in an exercise in June 2001, which was a Joint Service exercise. It consisted of the Navy, the Marine Corps, and the Army, and that's kind of important because it really wasn't what this ACTD started out to do. It was really a Navy, Marine Corps ACTD (i.e., the Extending the Littoral Battlespace (ELB) ACTD (Slide 2)). So the part we're in right now is the two-year residual effort of an ACTD. This effort is really focused on transition, but what happened is there were some things that Admiral Blair and other Four Stars said about the ELB ACTD, in particular they said: "We have got to have this now."… and I will show you what it is that they saw. They said that they really couldn't wait for the acquisition committees. They really needed to have it sooner.

So, in the next chart (Slide 3), you'll get an idea of what Admiral Blair and others saw. For the first time, he (Admiral Blair) went around to these different services and on their tactical display he saw the other services, not as an aggregated symbol like you would if you were up at the higher level commands, but at the tactical level, the maneuver level. On the next chart (Slide 3) we can see it more clearly. You could see the individual elements and you could see their positions. He saw that he could really do fires for maneuvers. So, if the forces could see each other, if they could do planning together and share overlays, then they could really fight together more effectively and they would not kill each other.

So, this was what they saw in the ELB ACTD that they wanted to have sooner, and Admiral Blair said that he wanted to have it in PAYCOM and he wanted to have it in WESTPAC, and so on. As we look at the capability, this is really what we're trying to do (Slide 5). This is a figure that we've drawn with each of the services, and inside these ellipses we've indicated their command and control applications at those various levels. What JTF Warnet is going to do to enable Admiral Blair's vision, is to connect the LANs (Local Area Networks) at those tactical levels of the services. Also, it's going to attach to their databases, subscribe to their data, and publish data from the other services, to enable Joint war fighting… and you realize, we don't do that now. Currently, the services tend to take turns. There are some exceptions to that, like how the Army and the Air Force fight together, but also to provide (Slide 6) horizontal connectivity between the services to tie them together at the tactical level.

Now normally when you do a JTF exercise, in fact always when you do it, it will be associated with one of the other services. Now when you do this, nobody shows up with extra stuff. You really do it out of your hide. So, to do the JTF the service that's allocated the function just uses its normal resources… the organic assets that they go to war. So, what JTF Warnet is bringing to this joint environment and which will be organic to each of the services, is the ability to translate to and from their databases, because the war fighters have told us that they want to use command and control displays. We don't want you to give us another one (display). We want

to use what we normally use. JTF Warnet is providing that translation. It's also augmenting the services' communication capabilities, both within a service and between the services at the tactical level. JTF Warnet is doing this with what we call a surrogate for the JTRS Wide-band Network Waveform Radio. We will show you in a little more details what we're using and how we're doing it.

This is really the problem the warfighters want JTF Warnet to address, and if we go back to Colonel Wood's question, how it demonstrates experimentation? As shown in Slide 7, in FY04 we deploy. Our experiment is really about joint war fighting, getting the services to fight together, not about the technology we're using. That was already demonstrated in the ELB ACTD evaluation data.

So, if we look at the components that I just described (Slide 6), there are two kinds of radios that we're using. One is this surrogate JTRS radio and it happens to be a BAE VRC 99, which is a non- programmable radio. However, it is a network radio, so it has some of the attributes that we think are going to be in the JTRS radio. It is the closest radio we can find to that kind of capability today. The other radio link is a tactical common data link. This is sort of the next generation standard from CDL. It gives you an IP high-speed point-to-point link. I'll show you a little bit more about the capabilities of that. But the importance here, in this tactical environment, is that it gives you a very long reach line-of-sight communications capability.

The ELB ACTD concentrated on line-of-sight communications and avoided SATCOM. In JTF Warnet, we really want to take advantage of the services' legacy communications, whether it's EPLRS or SINCGARS, but especially SATCOM because the services rely heavily on SATCOM. The real key here for JTF Warnet is the translation. Remember, the services told us they don't want another application. They want to use the applications at the tactical level that they know and use today.

They want us to provide this transparent translation service for them. I will show you how we're doing that. Again, these are some of the systems that JTF Warnet will translate from and to (Slide 16). However, we will also provide some collaborative tools that will augment what they currently bring with them. These are really pieces out of a defense collaborative tool set that we'll use to foster that Joint planning and execution capability between the services.

System management: Part of our requirements from the warfighters is to be able to easily operate this system without a lot manpower. So, we are building a system management tool that's based on a commercial product which in turn is tied to the Joint network management system. We are making this tool as easy to use for the warfighter as we can, because that's going to be key for them to be able to use this system effectively, to see how it's working, to make changes, and to really understand what's happening.

IT Gateway to Link-16: We want to get some of these ground tracks into the cockpit. We want the pilot to be able to see a few of those blue PLI (Position and Location Information) tracks around the target. He's the guy that can make that last minute decision whether he is going to pull the trigger or not. Again, we're not going to change anything in the cockpit, we're using capabilities that are already there.

And finally, as Colonel Wood said in his presentation, "You can't solve all the problems with technology." You've really got to rely on CONOPS (Concepts of Operations) and TTPs (Tactics, Techniques and Procedures) to use the technology and the training material. How do

you use this technology to execute an effective Joint war fighting capability? Clearly, that's a big part of what JTF Warnet is all about… the documentation.

Here's a timeline (Slide 7), and previously Colonel Blair, and now Admiral Fargo, has concurred that this capability is going to be deployed in early FY04 in WESTPAC, probably targeting something like a COBRA-GOLD-04 exercise. Working backwards, we will undertake a pre-deployment exercise and a series of war games leading up to that, and we will then make the decision whether or not JTF Warnet is ready to go to these services as an operational prototype. Again, we're not an ACTD anymore because what happened back in April is that the JROC said, this is no longer an ACTD, this is a joint service initiative. JTF Warnet is not a program and it's not an ACTD. We're in a kind of no-man's land here. Following the JROC pronouncement we received funding from all the services (i.e., Army, Navy, and Air Force) and a lot of money from LSD, because it is a Joint initiative. If you've ever tried to do anything Joint, nobody wants to do it on their nickel. So, to do this and push it, LSD has put in about 60% of the funding.

Leading up to these pre-deployment exercises, we are building up the JTF Warnet capabilities from the ELB ACTD. This is a big effort and Dave Durham has joined us to build the C2TD (Command and Control Translator Database), which is probably our main development in terms of the additional translation we need to add to make this really into a Joint application. We're also adding some software-agents to really have the capabilities that the warfighters have told us they need. We are also going to buy some additional radios. We had 25 VRC-99s. We bought 20 more, and will have 45 altogether. These are expensive items and that's all we can afford.

Here is the navy picture (Slides 13 and 14). I usually avoid showing these pictures to a Joint audience, but I did want to show you how ELB and JTF Warnet flow into the Navy FORCEnet vision. So, we are very much teamed with these other programs, and hopefully what we will be deploying in FY04 will be an early implementation of FORCEnet, so that the Navy and the other services will get a chance to work with that kind of capability.

Now let's look at some of the hardware components. Essentially, we are a program right now that's fielding equipment. This is the VRC-99 radio (Slide 11). It's an avionics radio, running with 28 volts. If you are running it off 110 volts, you need a power supply. In applications where we have a long range, maybe to an airborne relay nerve, or if we have a lot of cable loss, like on a ship, we use a 51-power amplifier to overcome that. The radio itself is a 10-watt amplifier.

The next rack shows some of our servers, our router, our rooter, and some of the other components (Slide 10). So, there are basically two small racks like this and the radio rack. It's a relatively small footprint, to bring the JTF Warnet capability to each of the service nodes that will have them.

For the ELB ACTD they used the A-band version of the VRC-99. We found that there are a lot of problems in the D spectrum. This certainly makes a strong argument for programmable radios. It is very difficult to buy a radio on a fixed band and expect to use it anywhere in the world and get frequency allocations. The FAA is just beating us alive in that A-band… and the B-band. Guess what, the Administration gave part of that away for third generation cellular? So, we will need to be able to change them in the field or put in different boards, or we can make them either A-band or B-band to give us more options in respect to frequencies. Again, it's a network radio. It's got an Internet connector on it, so it's very easy to use in a network sense.

We will probably connect the ships together with SATCOM or if we need to, we can have an airborne relay node in there, either with the TCDL or a VRC-99 node dividing that relay. Again, the TCDL gives us that long-reach factor to the shore forces. Likewise, we'll give each of the other services some of the VRC-99 radios. In this way they can use those to augment deficiencies they have in their current communications within their service. And then there is the Warnet part, the joint part that ties it all together. But again, remember, nobody shows up with this part. When the services deploy they take all this with them. Then when they get into the theater, and now they're in a Joint exercise, they push a button on the system management console that says "Joint". Some of those assets are allocated to the Joint connectivity, and some are still used within the service as a service Internet. And again, you have airborne relay nodes that tie together those various networks.

Next, you have UAVs (Unmanned Airborne Vehicles). This just happens to be something that BGen Catto (Commanding General, Marine Corps Warfighting Laboratory (MCWL)) is watching very closely, because it was started by MCWL as an experimental warfighting capability. We will use it in JTF Warnet, certainly in the exercises, to provide that airborne relay capability (Slide 12). The VRC-99 fits vertically in the nose cone, in this way either carrying the flare payload or the VRC-99 communications payload. It gives you a vertical take-off UAV that uses the same fuel as a HMMWV (High Mobility Multipurpose Wheeled Vehicle). This is totally organic to the Marines, so that they can deploy on demand an over-the-horizon communications capability.

OK, now to the C2TD (Slides 16, 17, 18, and 19), which is really a translator. What happens when you turn on the C2TD? All of a sudden the services will be seeing not only their normal command and control display, but now they will also be seeing the other services. In addition to seeing the blue and red tracks, they will be able to calls for fire together. If their applications support that, they can do overlays and battlefield geometry. C2TD also uses an object model database, so it's able to do things like blue-on-blue alerts. In other words it gives you an alert if you have a potential fratricide situation with your own fighters. Shown in Slide 16 are the various service applications that C2TD going to translate as well as publish data to. The Link-16 gateway could be in any service… I am showing it in the Air Force here. The communications just enable the flow of data, but the C2TD provides the transparent capability at the tactical level. As you are all aware, we have very little interoperability right now.

Next, Slide 17 shows how that translator is built? It is built on the MCSIT (Multi C4I Systems IMMACCS Translator) component of the IMMACCS (Integrated Marine Multi-Agent Command and Control System) program, funded jointly by MCWL and ONR (Office of Naval Research). It provides independent channels for input and output and is very flexible, and very scalable. Slide 18 shows the status of the message translation that we plan to accomplish with MCSIT. Oh good, the logistics one is listed as well. We are prioritizing these based on what the warfighters told us, and by golly, they said they want some logistics messages in there, so we will translate those between the services. How are they going to use logistics between the services as part of the CONOPS and TTPs? That's enough of a problem within each individual service, let alone how do you do it in a Joint environment? That's the experiment… that's the kind of thing that you learn by doing this.

As a management tool (Slide 19), C2TD will allow us to hook up geographical areas as overlays. You can manage the kind of data you get from these geographical areas in terms of both subscribing and publishing. In this way they will be able to control both the data from their own

service that goes out to the other services, as well as the data that comes in from the other services. JTF Warnet will provide a Defense Collaboration Tool Set (DCTS), but the important part here is how to use the DCTS a Joint environment (Slide 20).

In this next chart (Slide 21), you'll see one way that we do that. We found in the ELB ACTD that it was best to have the servers distribute it in each of the services, so that over the wireless tactical network it's really server-to-server as opposed to client-to-server communications. We found that worked a lot better. Again, that's how we'll label that collaboration between the services. They'll be sitting there at their normal collaborative application, but instead of just doing it within their service, they'll point it to the Joint server and they'll be able to do collaboration between services.

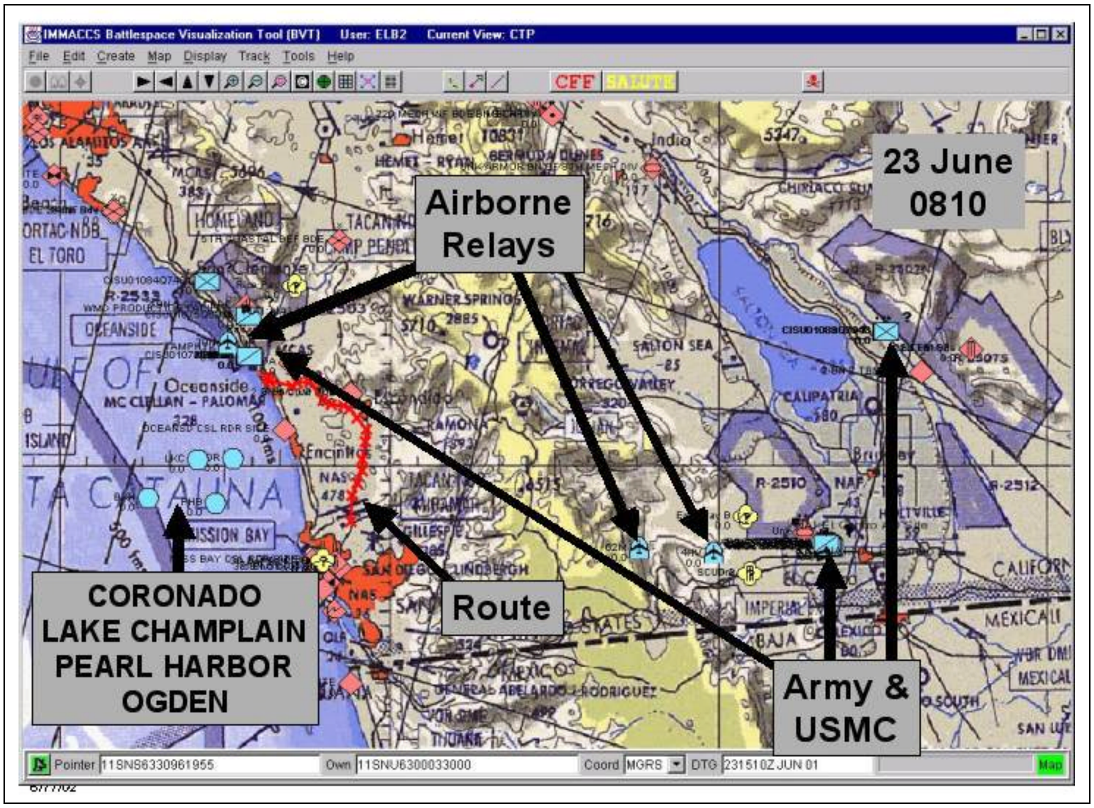
One of the things we learned in the ELB with these TDMA radios is that you want to have only five to eight of them on a sub-net to get good throughput. So, some those will actually have multiple VRC-99 and they will serve as gateways between those sub-nets… that way you keep the performance up. So, that's how the VRC-99s will support deficiencies within each service as well as tie those services together with reasonably high-rate communications capabilities… that are not currently available.

Security is a big problem (Slides 23 and 24). So, here we are, we're going to the services and they've got routers, and then we are going to have a JTF Warnet router and plug into their router. So, now we have broken all of their security rules. So, this is really something. We are working with each of the services, and we are working with PAYCOM, to do this? How do you provide this kind of secure connectivity here? To get us through this we have asked PAYCOM to be our DAA. I won't go through the details here with you, but what we're doing is we're looking at all the services per their requirements. We'll come up with a super set of these requirements and we'll test all of those. We'll provide the documentation of the services, so that we will have a system that's accredited to use and plug into the warfighting systems.

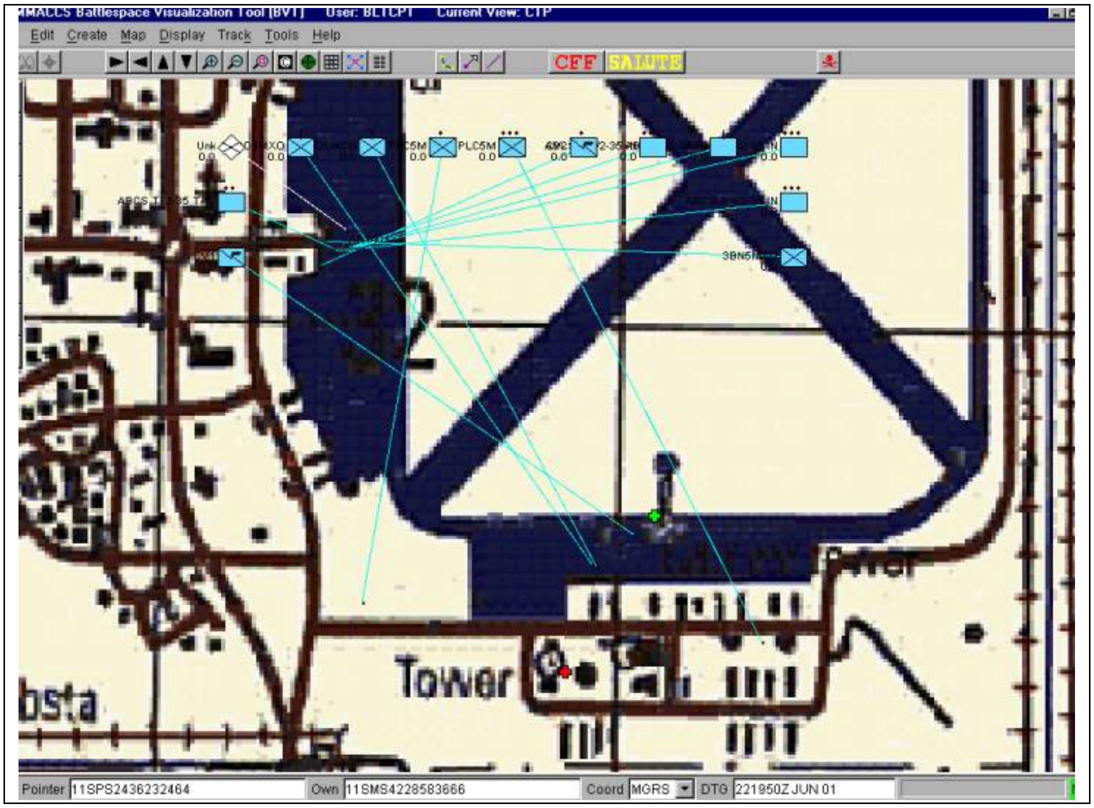
Documentation is again a major part of this job. We've got a whole hierarchy of documentation. I won't go into it, but some of this is on our web-pages, which you can access from the ONR web-site (www.onr.navy.mil). Go to tactical, and under military you'll see JTF Warnet listed.

Slide 1

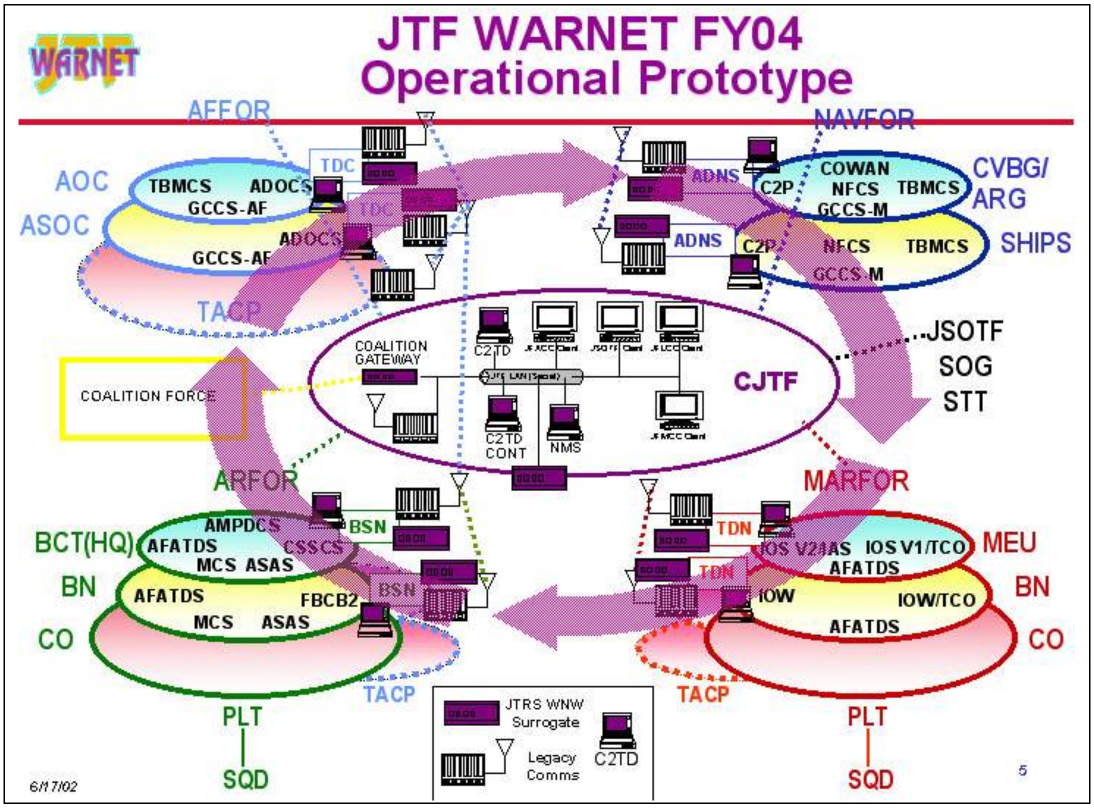
Slide 2



Slide 3



Slide 4



Slide 5

WARNET

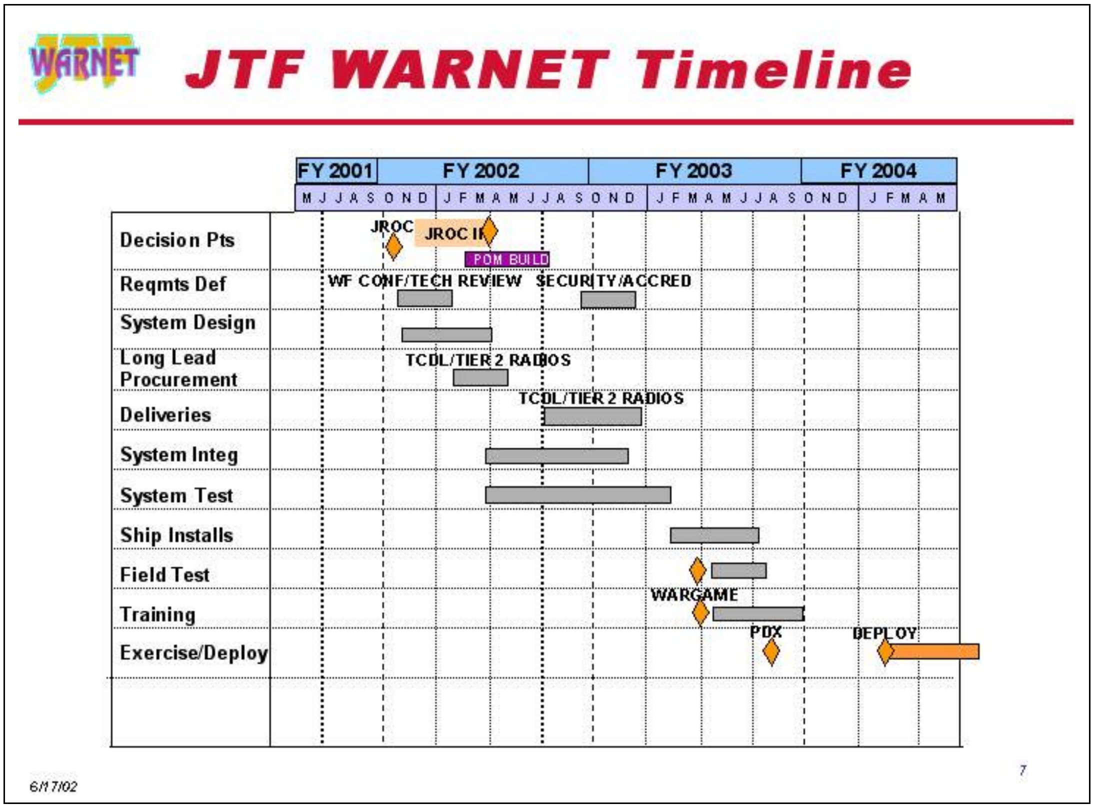
JTF WARNET Components

- Communication and Networking:
  - VRC-99A Radios for cross-service connectivity
  - Tactical Common Data Link surface to air network backbone
  - Complement Legacy comm links (e.g. SATCOM, EPLRS, SINCGARS)
- Command and Control Translator Database (C2TD)
  - Specified Message-Set Translators for:
    - USA: ABCS (AFATDS, ASAS, MCS)
    - USN: TBMCS, NFCS, GCCS-M, COWAN
    - USMC: AFATDS, IOS V2/IAS, IOSV1/TCO
    - USAF: TBMCS, GCCS-AF, JRE
- Collaboration Tools
- System Management
- IP Gateway to Link-16
- CONOPS and TTP development for a Joint, netted force

6/17/02

6

Slide 6



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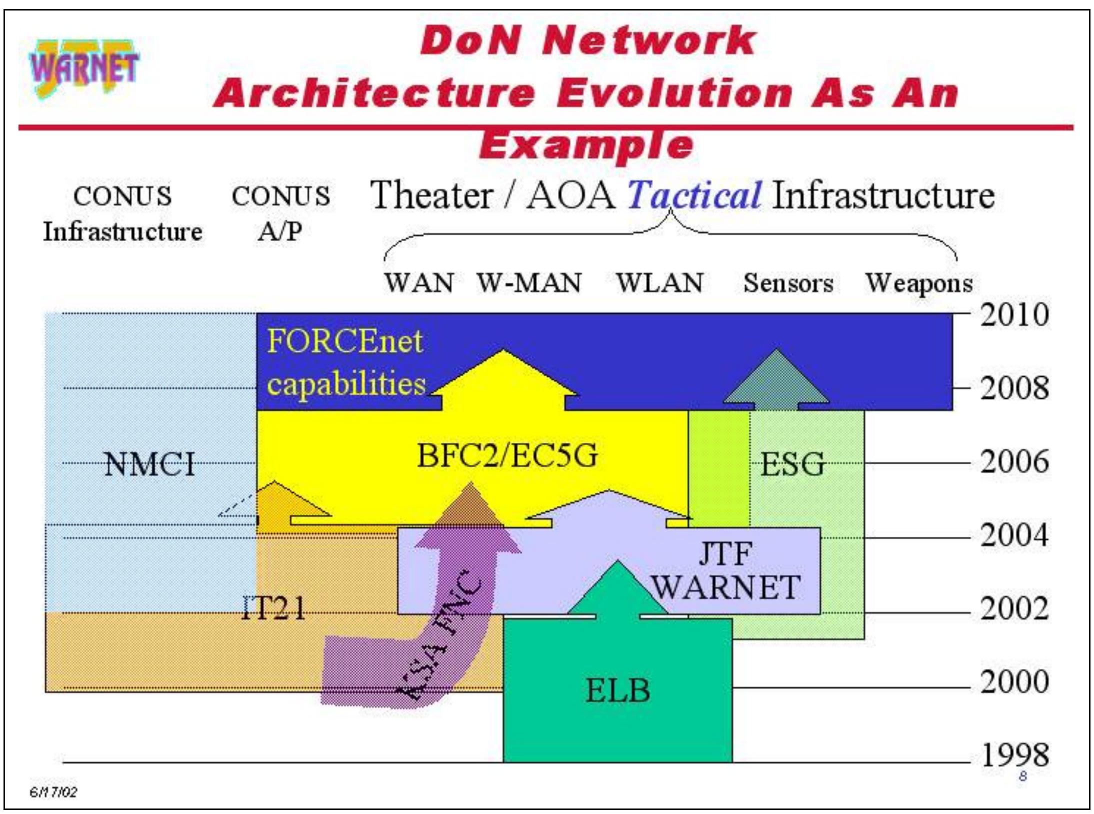

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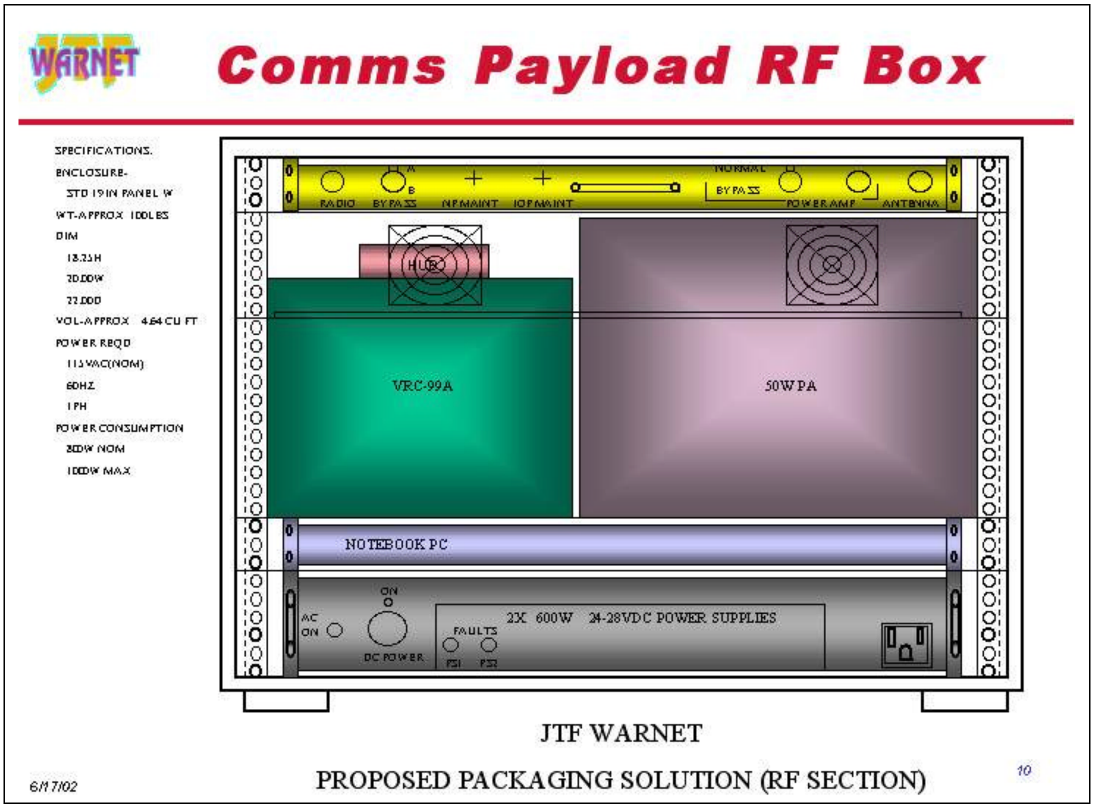

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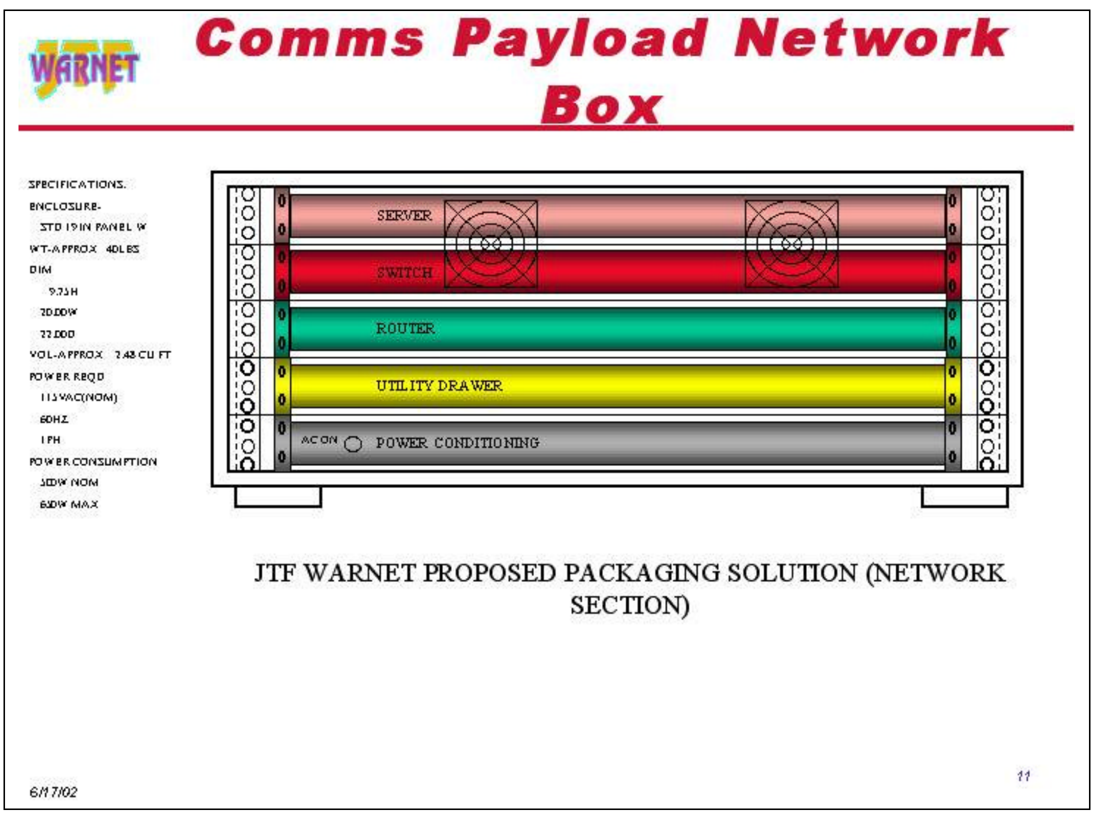


Slide 10

VRC-99 - Network Radio

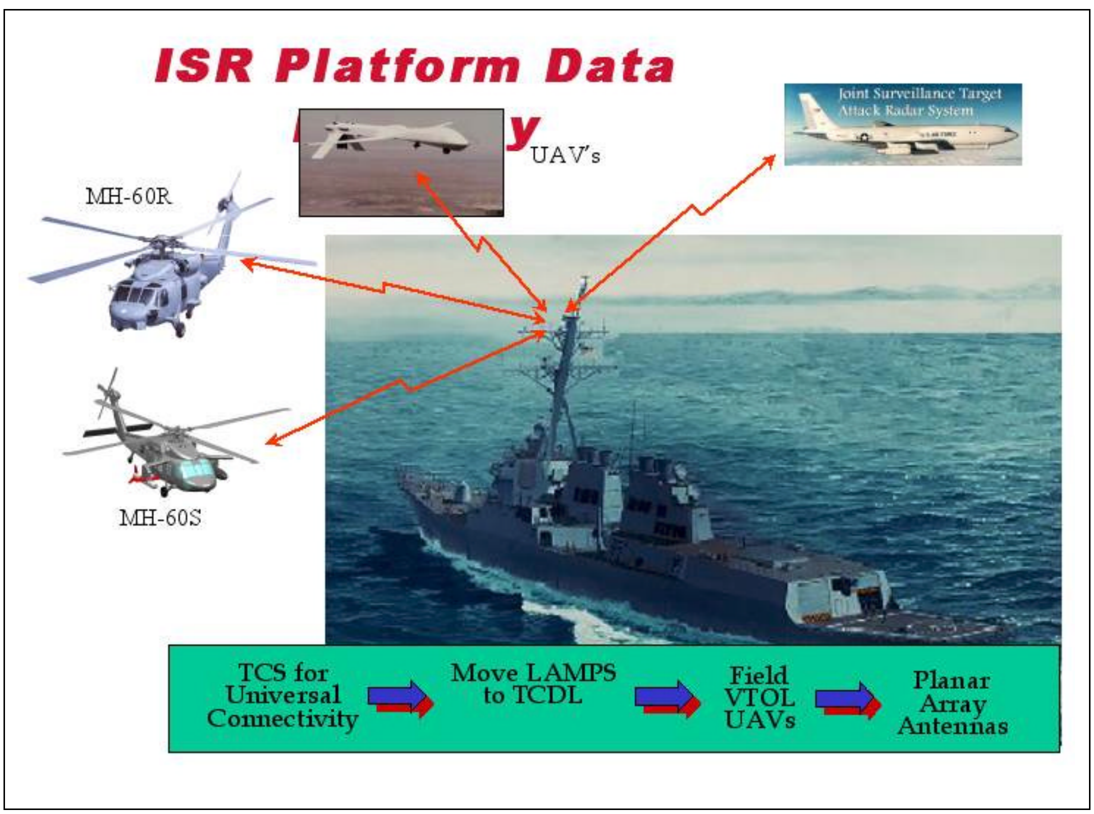
Specifications

- Direct Sequence Spread Spectrum
- RF Power: 10 watts
- Frequencies "A" Band: 1308-1484 MHz
- Frequencies "B" Band: 1700-2000 MHz
- Interfaces: Ethernet, RS-232, RS-422 with X.25 LAPB
- Data Rate: 625 Kbps to 10 Mbps Burst
- Weight: 25 lbs.
- Size: 3/4 ATR, 7.6"H x 7.5"W x 12.6"D
- COMSEC: Type 1 encryption

6/17/02

12

Slide 11



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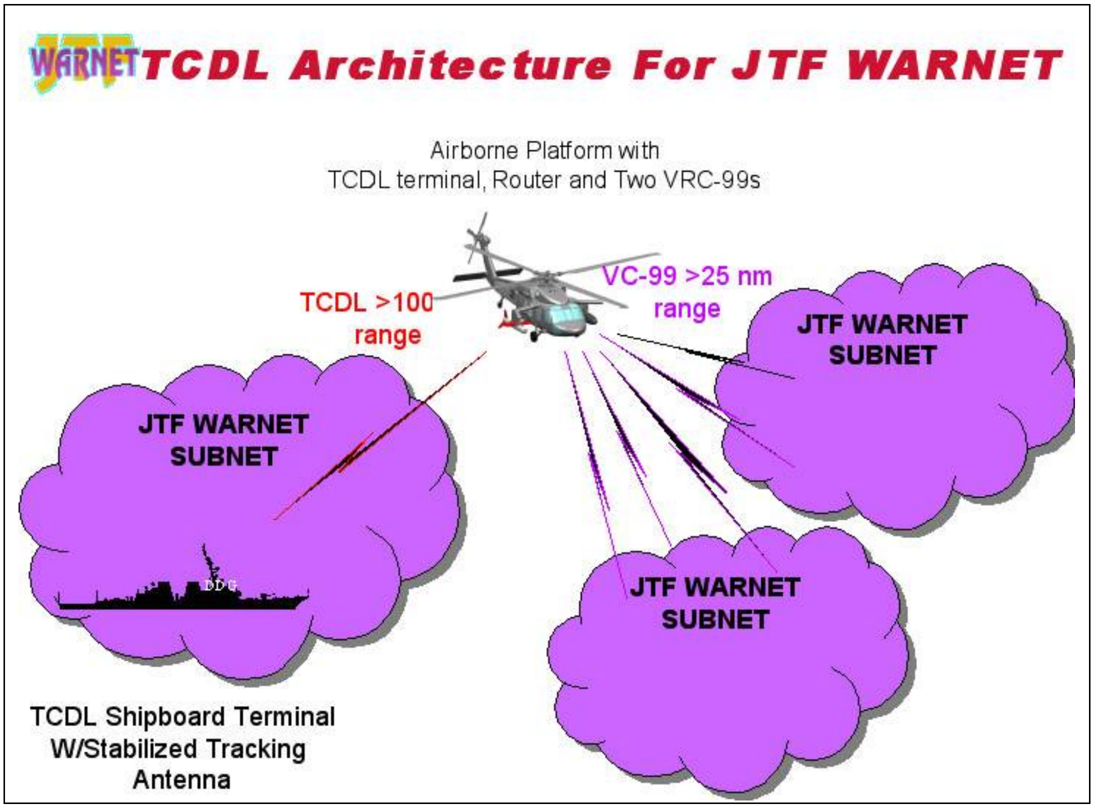

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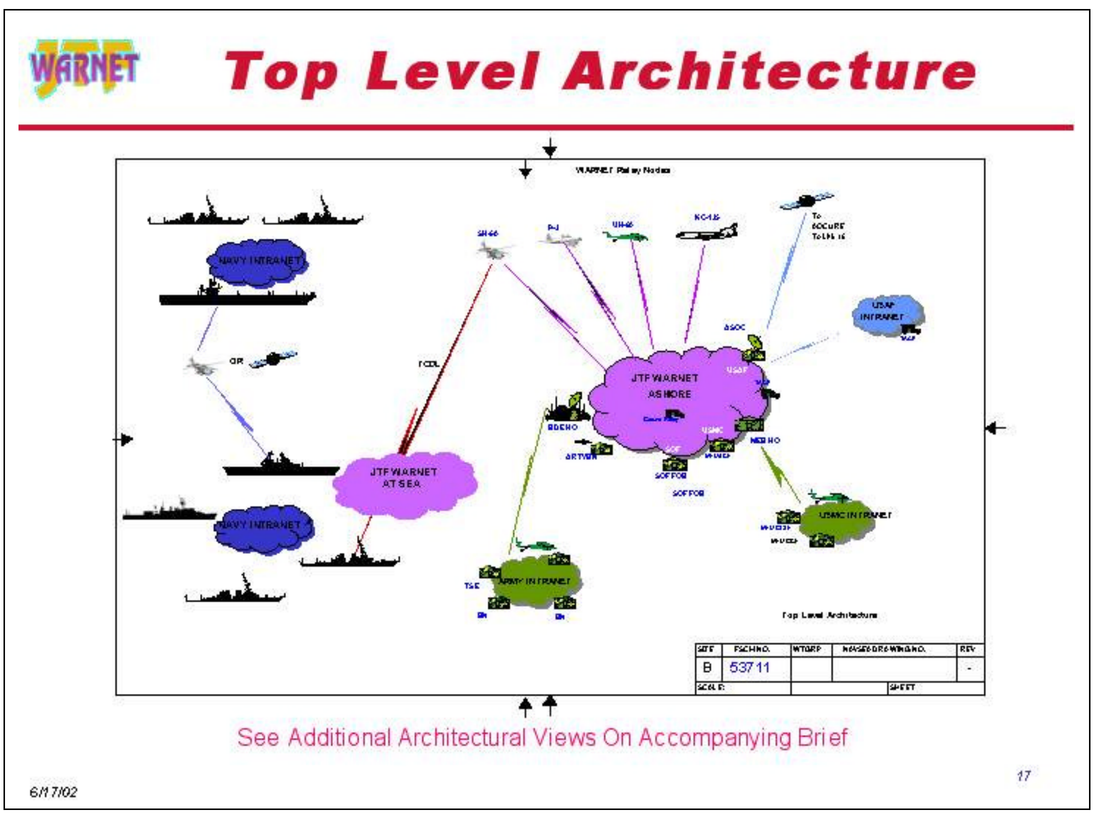

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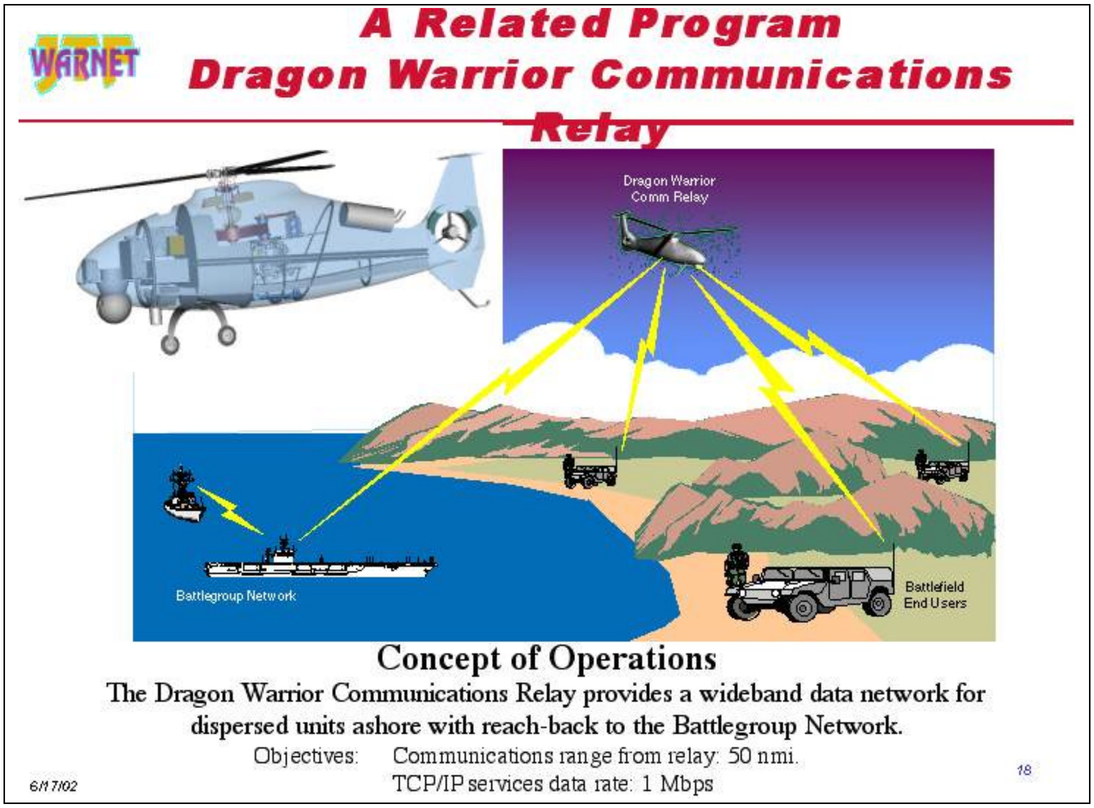

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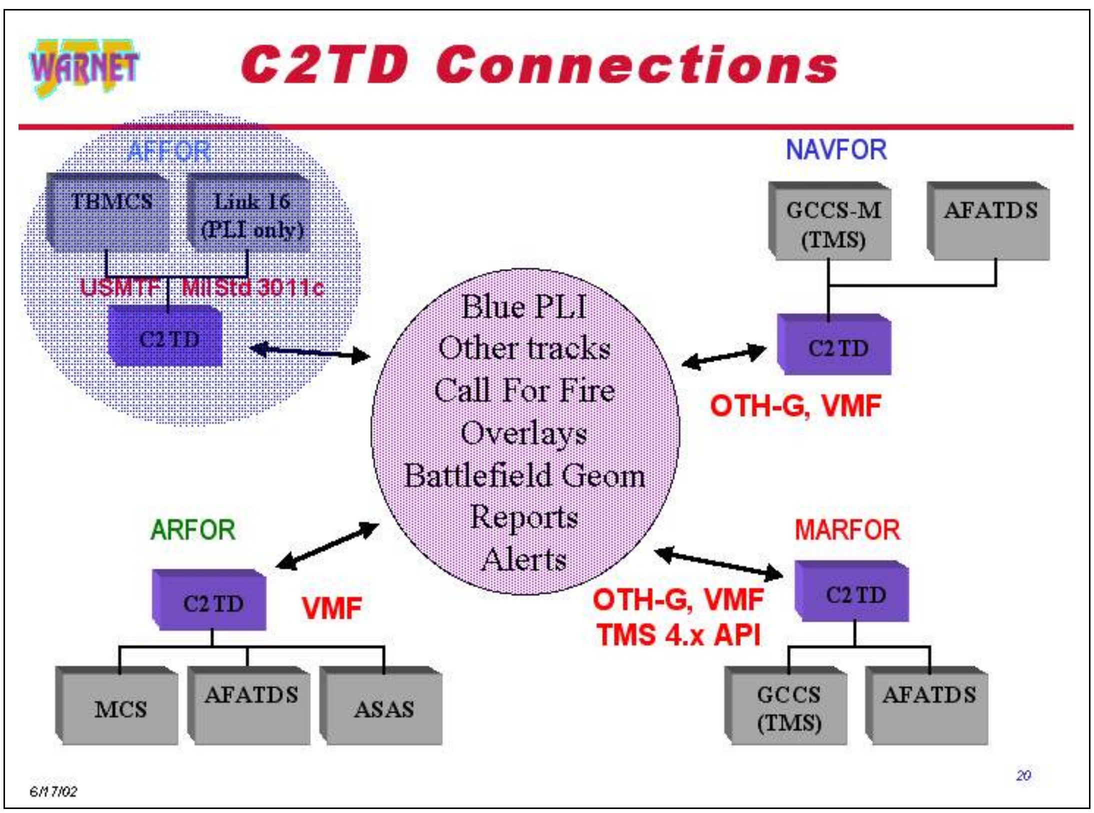

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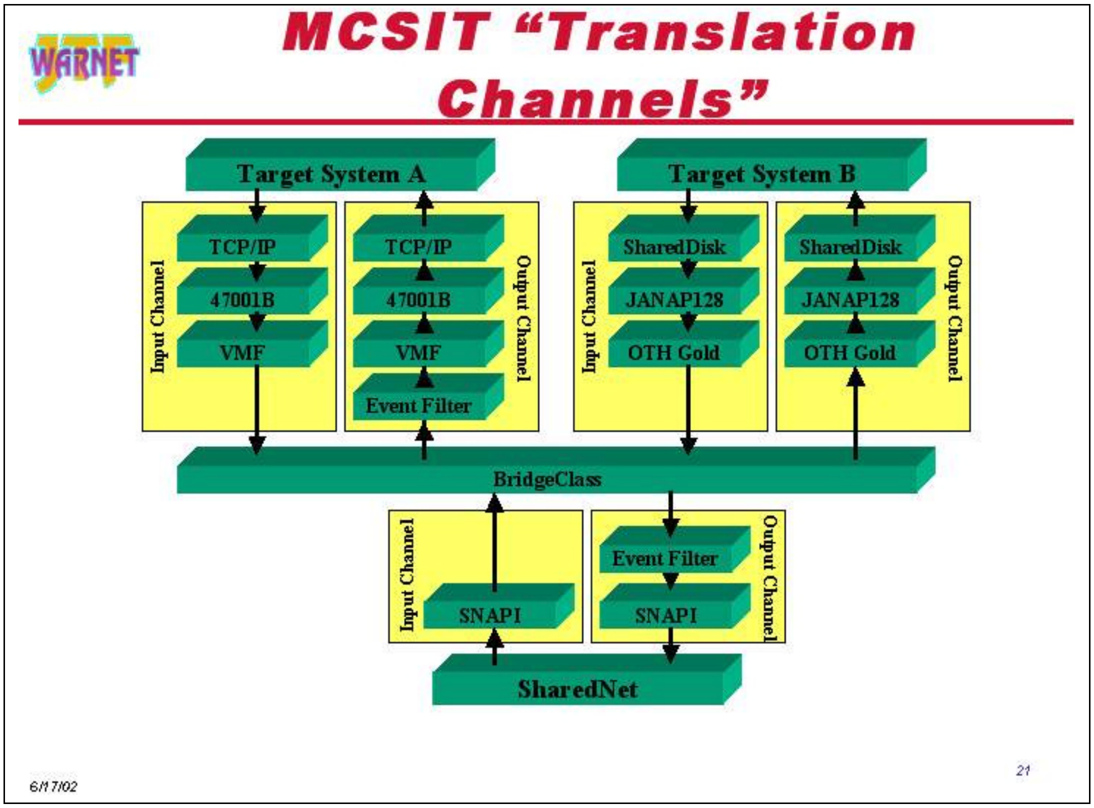
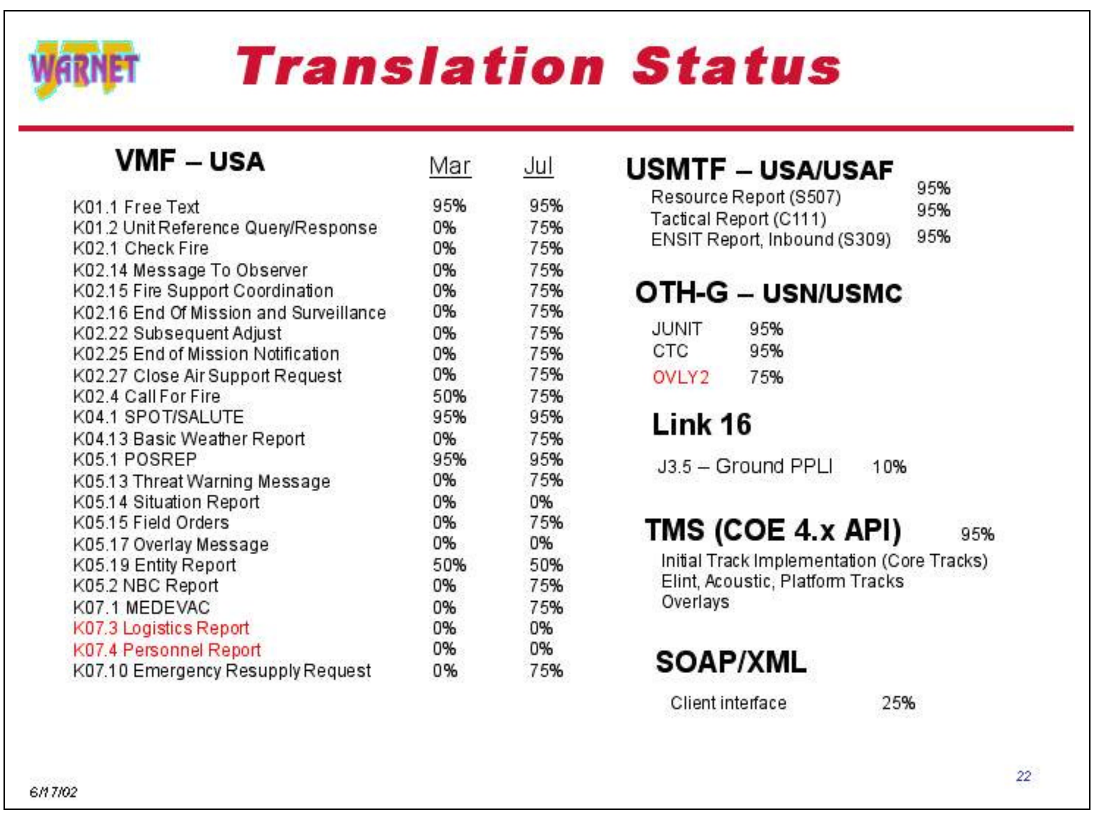
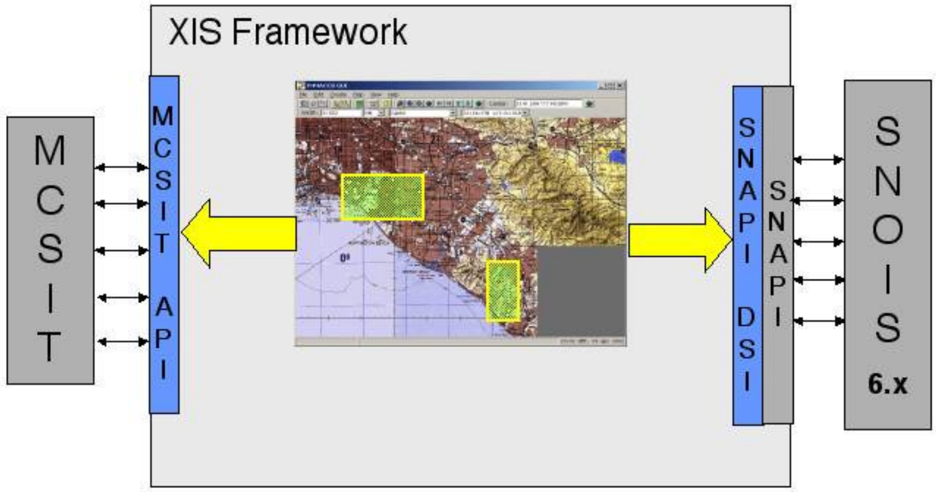


Slide 17



Slide 18

C2TD Management Tool



6/17/02

23

Slide 19

Collaboration CCI's

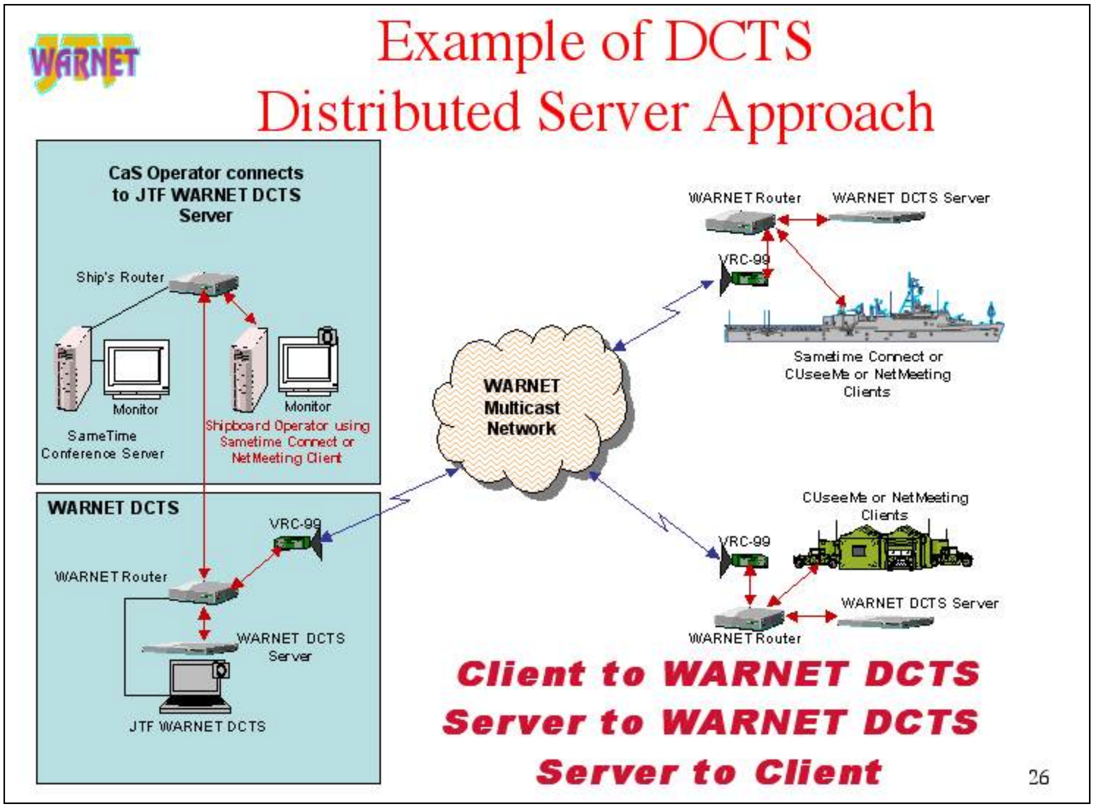
Defense Collaboration Tools Suite (DCTS)

- CUseeMe Conference Server and Client v5 (v6)
- NetMeeting 3.01
- Internet Explorer 6.0
- Dnews Newsgroup Server v5.5.1
- Mailsite Email Server v5
- Outlook 6.0
- WIN2K Server and WIN2K OS's

6/17/02

25

Slide 20



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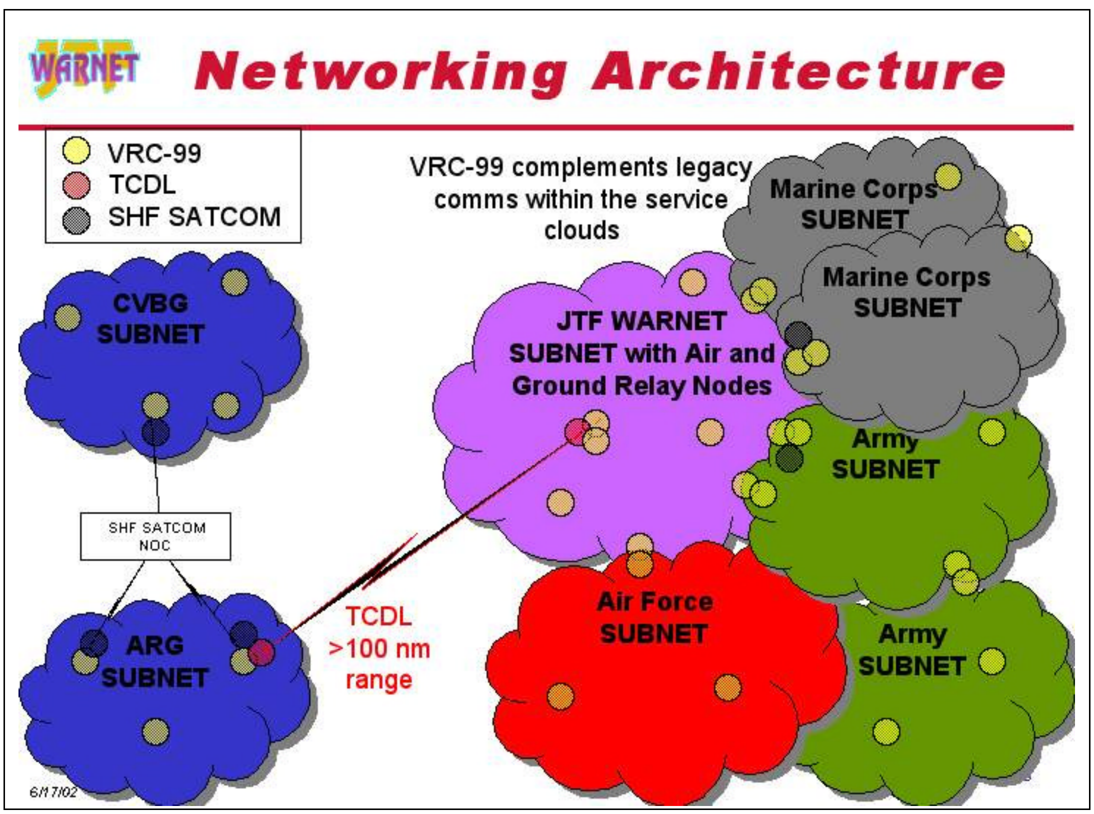
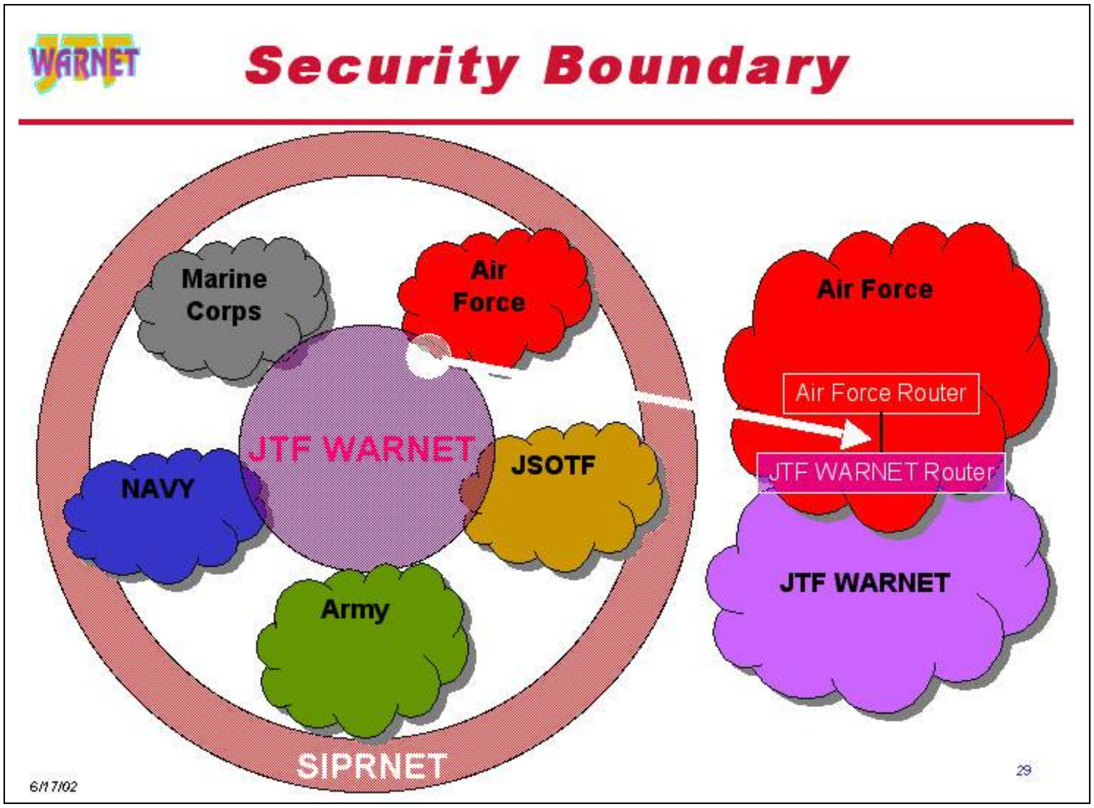
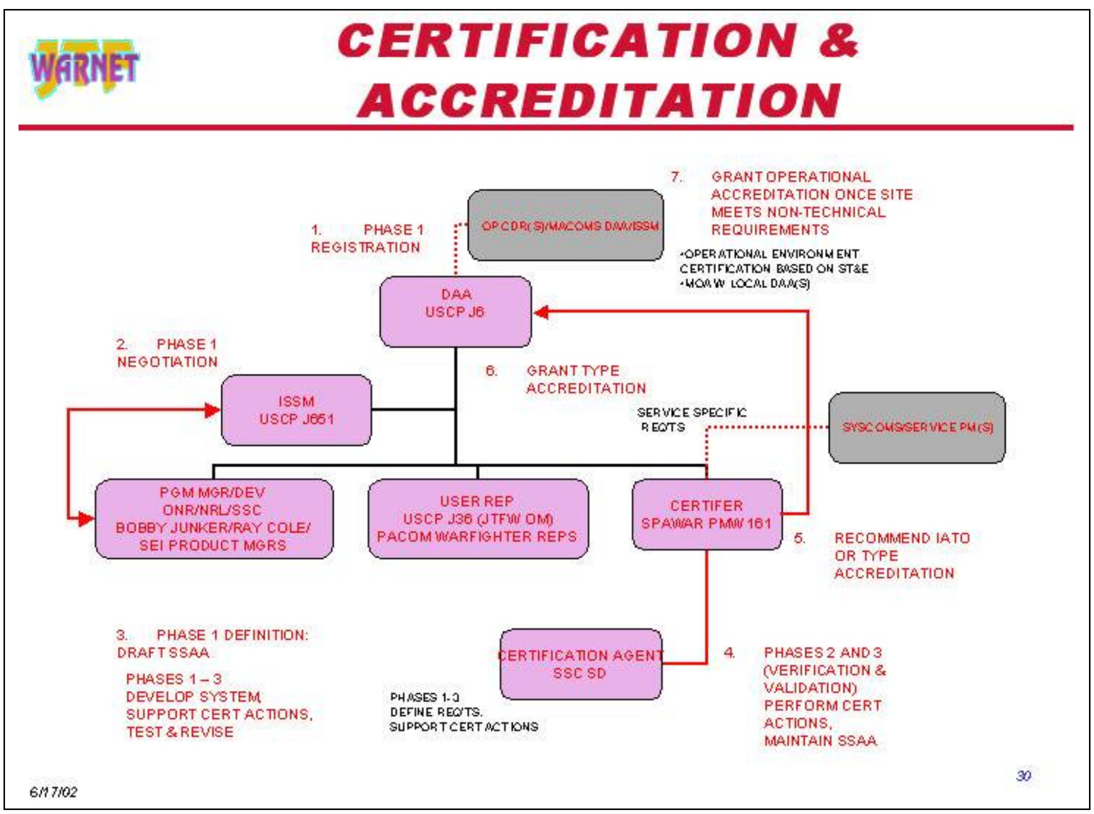


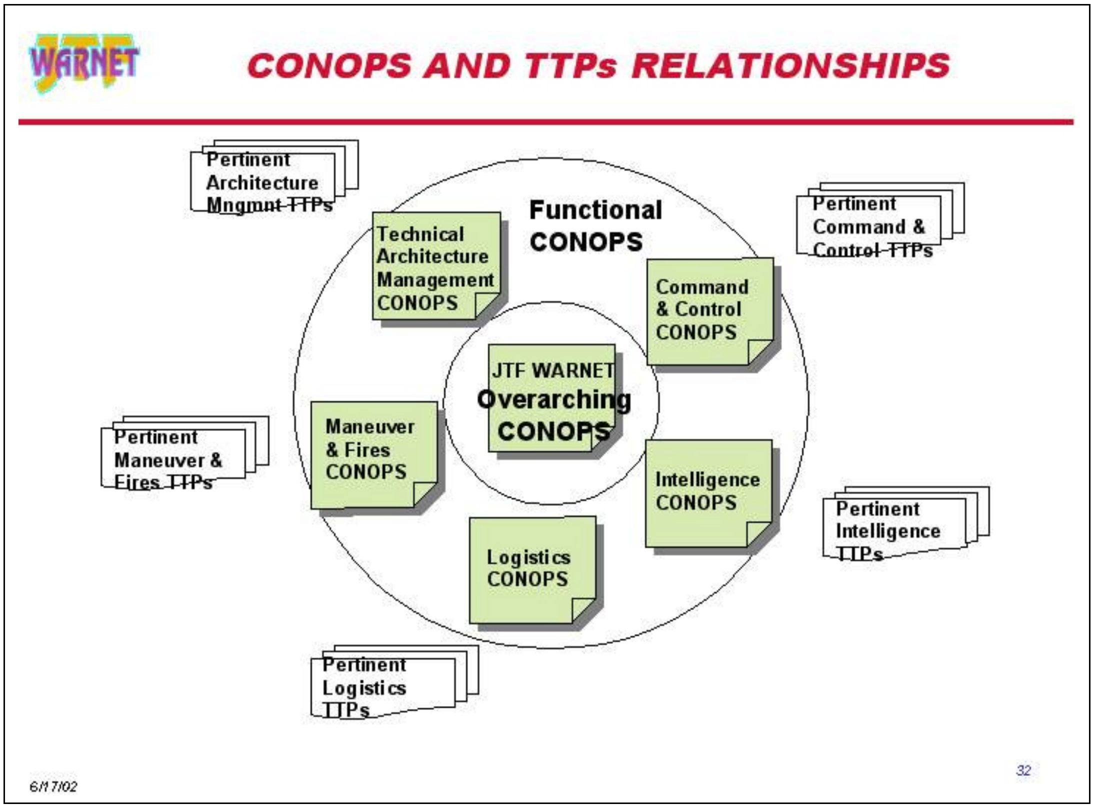
Slide 22



Slide 23



Slide 24



Slide 25

Slide 26

3D Battlespace Visualization With Live Video Overlays

Dr. Peter Burt
Sarnoff Corporation
Princeton, New Jersey

The situation that I want to introduce to you is shown here, where we have some kind of a conflict in an urban area, let's say. And we want to control this situation from a remote site, such as, perhaps a command and control center on a ship. I would invite you to think about Mogadishu as the type of operation we are talking about. However, in a future operation we will probably have a lot more information available to the commander and the war fighter, in the way of sensors that are in the environment itself (e.g., UAVs (Unmanned Airborne Vehicles), ground sensors, etc.). We can imagine that in the future it will have a very sensor-rich environment.

So, what we would like to do is to be able to take all those sensors and provide the information to the commander in a way that is most instructive to him. We want him to have total situation awareness focusing on things of interest and also we want to take the same information and provide it to the war fighter in a way that is most directly relevant to his moment by moment activity. The way we are going to do this is to basically start with a three-dimensional graphic-rendered model of the scene. In this case, the scene happens to be the Quantico MOUT (Military Operations on Urbanized Terrain) site. I thought that might be more relevant, so I switched a little bit from what you saw before. We will construct a graphically rendered model of that site, which means that an observer can view that site from many directions. If he wants to, he can zoom in and zoom out, take a bird's eye view, go down to the street, what have you. Then we will overlay on that model all the sensory information that is coming from the activity and this will provide the commander with the ability to move seamlessly in space, because it is graphically rendered. It also allows you to move seamlessly in time, which is to say, we have got the representation, we have got the information integrated together, we have got a recording, we have a history of all of that sensory data so that we can move back in time.

If you observe some on-going activity in the area of interest, you can see that there is a group of people, war fighters, the enemy, and what have you. I can cruise back in time and see where they came from, who they interacted with, and that sort of thing. So, that's going to be the integrating point. We will take all the sensor information, as well as other types of information available about the site, such as view specific information, names of buildings, streets, and so on, and just integrate it all together.

I am going to introduce this concept by way of a demonstration that was held just over a year ago here at the Quantico MOUT site. It was kind of a joint demonstration of a DARPA program we were involved in called Next Generation Internet, and a Marine exercise in which they were performing a peace-keeping mission. So, within the MOUT site there were a couple of opposing forces and then there were peace-keeping mission individuals charged with kind of monitoring local activities and taking whatever controlling actions might be appropriate. The facility was equipped with a number of sensors. In this case, they were fixed cameras. There were, I believe, 12 of them, and you are seeing views from six of those here. Now, in general, there would in addition be other types of sensors. For example, there would be ground sensors. There would

also be aerial surveillance, and what have you. All of these sensors would be data feeds. But the point I am trying to make can be well illustrated, I think, with just this set of cameras that looks a little bit like a bank of monitors from a guard facility. OK, in each of these we have live video. So, even though I didn't get them all turned on, you can imagine what is going on. This is kind of live action. The commander is seeing some individuals coming down this street. He is seeing some other individuals over here. He gets an appreciation that something is going on, but he has a very poor sense of how those activities relate spatially to each other, or how they relate to his own course of action. So, what we need is some way of taking that information, and again, in the future, it is not going to be six cameras, it is going to be 100s, and integrating it into a common view. That is the need. What we are going to show here is this kind of model-based graphical-rendering approach, which basically lets us say take a number of actual cameras, integrate this live information into a new view (i.e., into a model) and then render that view as a virtual camera. So, a user can view what's going on in the scene from many perspectives if he wants to. Each user can have his own perspective on the ground, or in the air.

Well, let me show you what that looks like. So, here we have again a representation of the Quantico MOUT site. It is based on a graphically rendered model. We have indicated where there are some cameras and we have projected onto the model the video that is coming from those cameras. So, we can see this swath is a footprint of this camera looking down the street. There is a similarly footprint up there. So each of these kind of lighter areas is actually live video overlaid on the rest of it, which is a previously constructed model.

So, here's what that same set of six cameras looks like. Here is one group of vehicles coming down this street. We can kind of zoom over and take a look at that. We see on-going activity surrounding that vehicle. Each of these patches obviously represents the view of different camera. Actually, let me go to the next one. If you remember, there was a group of people coming down one of these streets, that's that group. Now we are just pulling back, taking a larger view, and we see over here the other group coming down this street. You can see immediately where these various activities are taking place and how they relate spatially to one another.

This is what we mean by live integration of real-time sensor information into a model and then providing the ability to kind of render or present that information from a user's specific perspective. In this case, we are just showing video, but clearly you can include in that same representation, other types of information, alarms from trip wires, ground sensors, aerial vehicle information, and so on.

All right, so what I have talked about so far is just a framework for taking a lot sensory information, structure it and present it in a way that is immediately intelligible. Now we can go a step further. We can process that sensor information for the purpose of automatically detecting things of interest. So, in this case, we are demonstrating a kind of processing that detects these people as they move through the streets, or these vehicles, and as we detect them and trap them, we can overlay the information on the model as well. In this case, we are doing this symbolically. So, what you are going to see is another fly-through of this same scene. This is that group of persons on the street, and what you're seeing is where they are now symbolically represented and where they have been represented as tracks. You can cut this time sequence and get the history. Now, to underscore, this is a process of both integrating information together and accumulating that information, so if at any time, we want to kind of play back in time we could in principle see where those folks came from and who they interacted with.

As I have mentioned, the framework provides a kind of common representation in which you can integrate other types of information and other sensors. For example, unmanned air vehicle sensors, organic air vehicle sensors that might be flying around town, ground vehicles, and even sensors that the soldiers might carry themselves or place on the site. To illustrate that, I am going to show you how we can integrate a video from an unmanned air vehicle, so that it is the same site. In this case, there is a small UAV that flies around, and I'll show the example video from that UAV. We're just flying and watching this individual running thorough the street. This is just direct video fed from the UAV. An observer can certainly get a sense of what's going on, but can also quickly lose track of exactly what he is looking at, where the person is going, where he has been, and obviously how he might interact with others.

So, what we are going to do is to take that same video and overlay it on the model that I showed you before. It is going to be a little difficult perhaps, for you to see. Here is the video being projected onto the model. There is the guy. So we can clearly see, he ran down this street, and then he comes down this street. So, we get a clear view of where he is, what he has been doing as he moves along.

Now in principle, that is one camera. We can have multiple UAVs. DARPA likes to talk about future combat where you've got swarms of sensors and UAVs flying around. Well, how are you ever going to make sense of all of that? Well, here, we've got two, and you can see that they are just laying their video down on the same model. So an observer sees the information, and doesn't have to be aware of where it is coming from. It's a rendered-representation, so we could kind of fly around and see that activity or replay it and see it from different directions.

So, that is the sort of information that might be made available to the commander. The commander, or an operator in the command and control center, could chose what information is important, chose the perspective, and the kind of domain that you see. Now you would also like to be able to provide this information to the warfighter on the ground. And obviously, the warfighter on the ground doesn't want to have to leaf through computer displays, and so on. You need very direct information, exactly what he needs at the time. Imagine that the warfighter has a head's up display. He can see the scene and then overlay on the scene the information that's pertinent to his mission. For example, he is looking up the street and sees, overlaid on the display, an indication of where he's supposed to be going. Prior information has indicated that there is a sniper that he should be aware of. The model shows where that would be, as buildings or labels, streets or labels, and that sort of thing. All of that information can come from the same model, just tailored for his view.

So in principle, graphics would allow you to go right in the door, there. It's just a matter of how much of that model has actually been populated with useful information. So, it is very easy to steer this thing and go right underground. All of the examples that I've used so far involve this kind of urban area with distributed cameras. The same sort of notion applies if you're operating in rural areas and undertaking a much wider surveillance of the scene. And for example, here is the video from an UAV, where we have projected the video right onto the model scene. This is graphically rendered three-dimensional terrain, and what you can see here is the footprint of the video. You can look directly at the video and see things going on, or you can lay it on top of this model and you can kind of see where it is, where you're panning. At the same time you can accumulate all of this information. This is live imagery, this is historic imagery, where you can accumulate the live imagery into a mosaic, kind of paint out the scene and lay it on top of the

historic inventory. You get not only the current video, but everything that we've seen over the mission.

Let's go back to the notion that I brought up at the beginning. In a Mogadishu type of mission the commander could see activity going on in the scene, he could see through aerial cameras, see where vehicles are moving, but it was very difficult to translate aerial video vehicles to geographic locations and coordinate activities. So, what I'm going to show you here is obviously an example. I will start in a second. This is raw video from an UAV. There are some vehicles in it. We would like to know where those vehicles are on a map or we'd like to see that video in the context of a larger model of the scene, so that's what's shown here. Ok, so here's the video. This red 'x' represents this particular missile launcher. The other vehicles have different symbols, and as they come into view, we detect them and lay them right on top of this common spatial representation or if it's more intuitive, we can put the same video right on top of a map. Again, I am showing one video, but the framework allows multiple surveillance aircraft or sensors on the ground or in the air, to be integrated together.

Ok, so all of that is taking current sensor information and putting it in an existing model. So there are issues that come up. What if we don't have an existing model? What if there are things in the image that are not in our model. Well, one of the things in the image that's not in the model are the vehicles and the people. So, going a step further, the technology I talked about so far is doable today. It's not deployed today, but it's doable today. What I am going to show you now is what we will be able to do in the future. We can generate models of actors, you know, moving objects that are in the scene as the event is unfolding. Here is an actual video sequence that we're generating from a three-dimensional representation of the scene. What we'll do is to construct from this three-dimensional representation a model of that guy as he's moving along… and it looks something like this. So here is the underlying graphical representation of that individual, it's triangulated surface representation, and when we project video images onto that representation we get a model of the person. You can pan around, and zoom in and out. This sort of thing may not be critical in a combat mission. However, in a minute I am going to talk about a training type of operation, where we are going to review an activity, a mission, or an exercise, and you'd like to really see how each individual carried out their part of the mission.

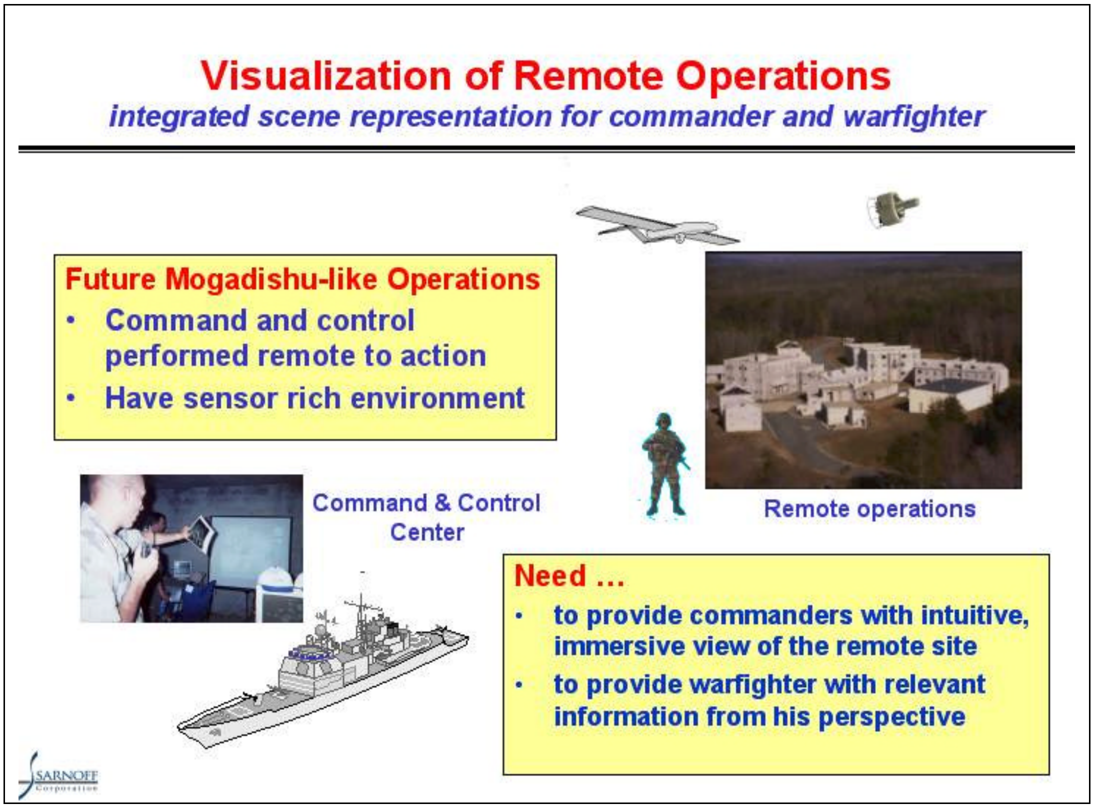
First, let me tell you a little bit about constructing the model itself. In the case of Quantico, we first flew over the site… there you have it. At any rate, imagine we're flying over in a little UAV, and what's notable about the video is that it's bouncing all over the place. Let's not worry about that. I think that's the only one that doesn't show up. So, at any rate, it's that town and we just fly over it and we grab together some video. From that video, we can now recover the shapes of the buildings. It's basically a motion stereotype of computation. So, here again, we kind of extracted the three-dimensionality of the scene (i.e., isolated buildings) just by processing this kind of raw representation and then ultimately end up with the integrated model. Now in this case, which was done a year ago, it took a couple of days. We flew over one day, then we played around in the lab and produced a model. But looking into the future, this is process can be made very fast, using both these motion stereo and modeling tools. So, you can go over and very quickly get a three-dimensional representation of the scene.

As a final example, I am going to talk about a current exercise that we are doing at Sarnoff. It's an ONR (Office of Naval Research) contract in support of training and we're setting this type of integrated, what we call video flashlight representation, at Sarnoff. So, here's an aerial view of Sarnoff Corporation. It's in Princeton, New Jersey. We flew over and we got some video

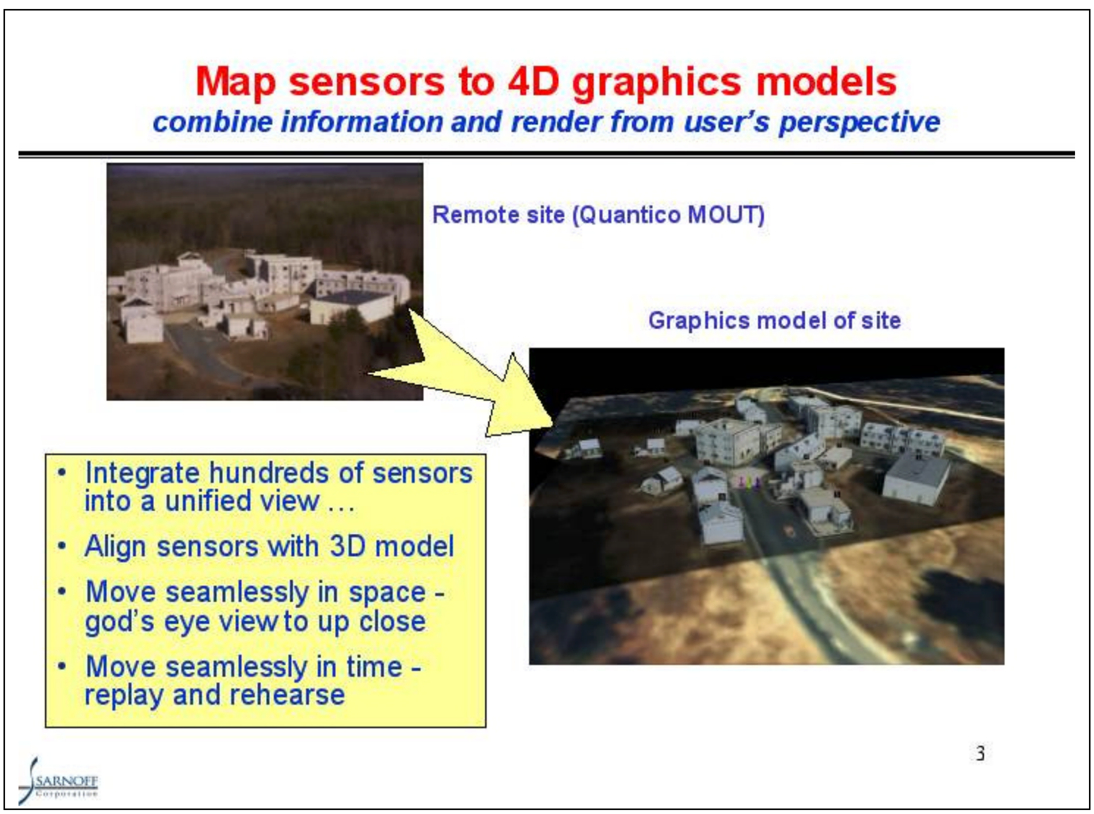
sequence. We computed a site map from motion stereo. We kind of automatically outlined some buildings and then extruded models of each of those buildings. It's largely an automated process, and then that becomes our model.

Now in this case, we want to go a step further. We'd like the representation to include not just outside space, but inside rooms. So, we are imagining that the Marines will come and they'll actually storm our building, and they'll go inside and apprehend our CEO or whatever. So, part of the exercise is constructing an internal model. I will show you in a second, models that were constructed by a laser scanner. So, here is just an illustration of visualization that includes both the outside and the inside. Here's Sarnoff. The exercise is going to take place in this building, kind of a lounge. You can imagine flying up and down, peeling away the building, and then this is the interior space. So, this mission is a training exercise. So, imagine that during the exercise there are going to be a lot of cameras. There's going to be a kind of accumulation reporting of the events, and then you can replay and see how each of the individuals and the operation proceeded in detail.

In summary, what we wanted to address is a kind of sensor-rich battlefield environment. In the future there will be lots and lots of cameras, lots and lots of video, lots and lots of other types of sensors. We'd like to bring that together into a common view that's immediately interpretable by command and control, and also be able to render it in a way that is appropriate for warfighters involved in an engagement. The idea here is to bring it all together in the context of a three-dimensional model, and where appropriate, lay video and other sensory information on top of the model. Thank you.



Slide 1



Slide 2

Concept Demonstration: Quantico

DARPA NGI program – July/Aug 2001

Command & Control Center for peacekeeping exercise:
Mission: monitor two opposing local populations

4

Slide 3

Distributed cameras monitor activity

[VIDEO]

[VIDEO]

[VIDEO]

[VIDEO]

[VIDEO]

[VIDEO]

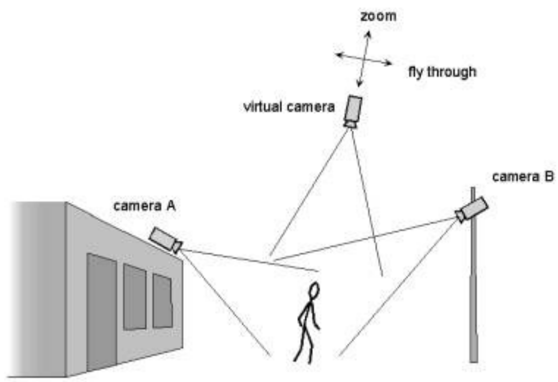
Individual cameras provide a disjoint view of the scene

5

Slide 4

Virtual Camera Concept

combine all cameras then render new views



Multiple cameras are merged to form a unified 3D scene representation.
Each observer views the scene with his own "virtual" camera.

6

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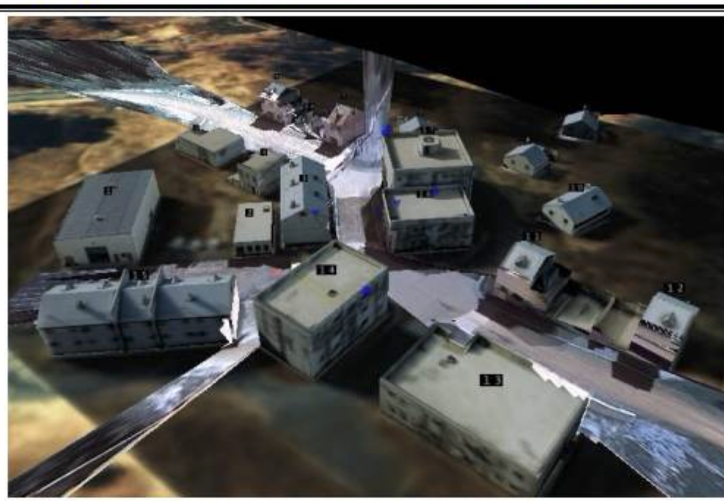
Slide 5

"Video Flashlights"

project live video onto model – render any view



[Video]

1. Supports "god's eye" view and virtual fly through.
2. Supports mission rehearsal and review.

7

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Slide 6

Alternative view
each user controls his/her own view point

[Video]

1. Supports "god's eye" view and virtual fly through.
2. Supports mission rehearsal and review.

8

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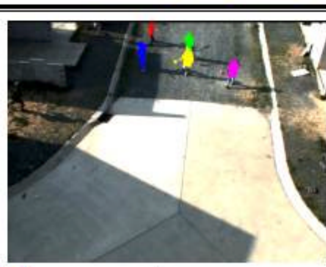
Slide 7

Automatically detect scene activity
overlay objects, tracks on the common scene model



Mob sequence

Jeep sequence

Tracks overlaid on flashlight display

[Video]

9

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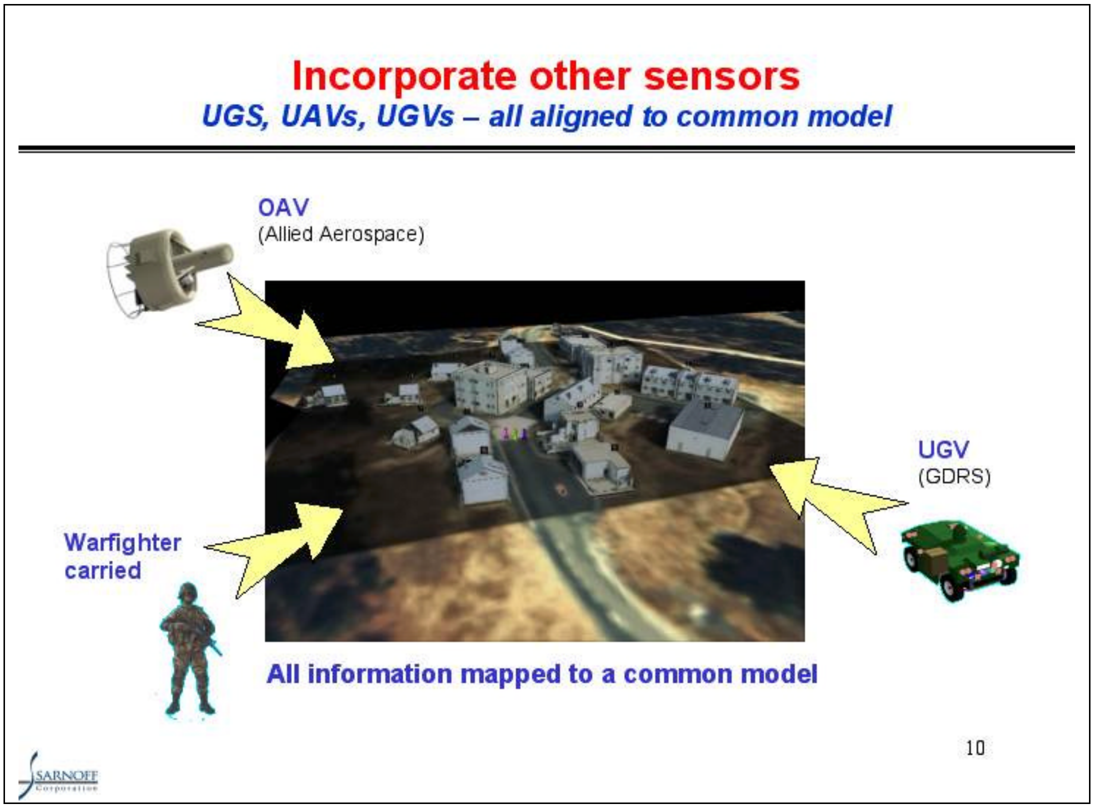
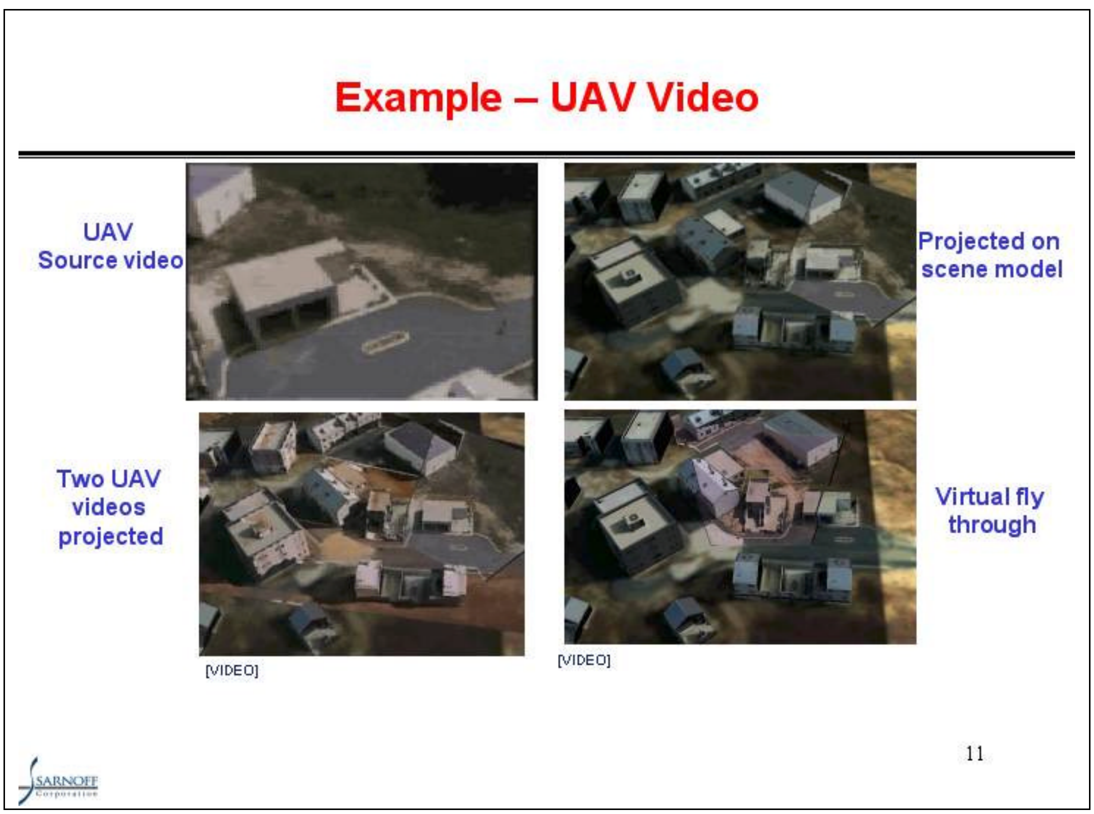
Slide 8



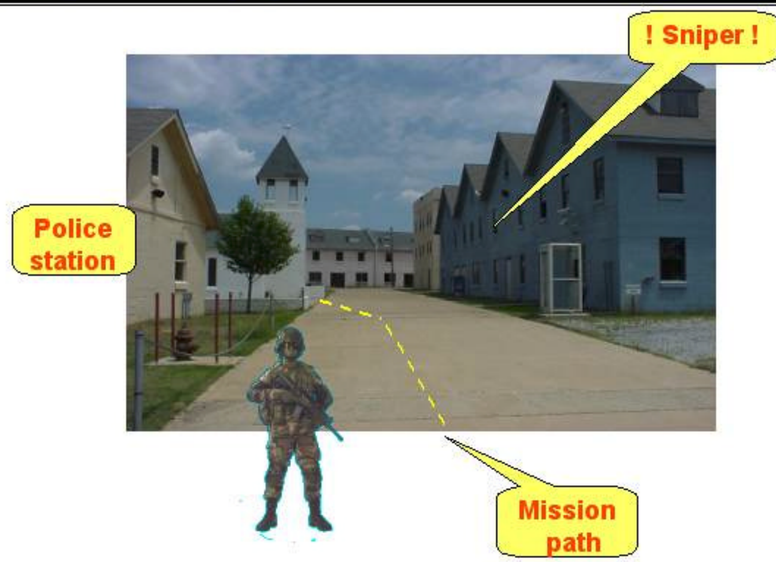
Slide 9



Slide 10

From command center to warfighter

head mounted display shows information in warfighter's view



12

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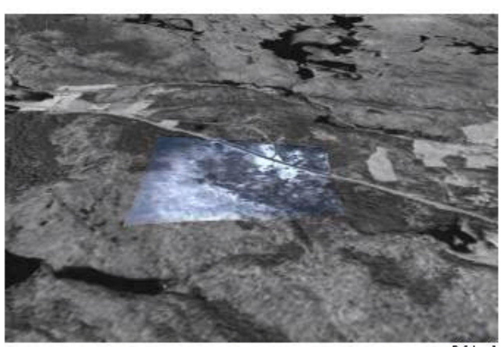
Slide 11

Integrate aerial imagery

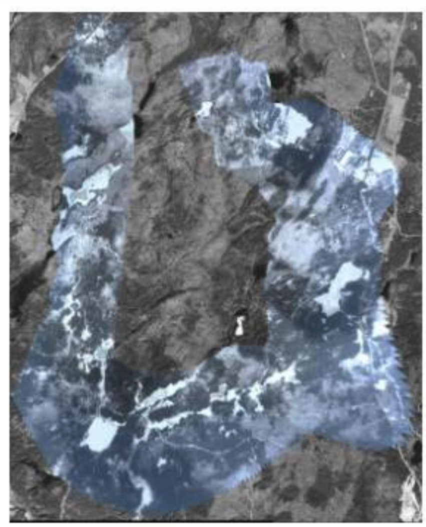
video overlaid on terrain and accumulated into orthomosaics

TUAV



[Video]

Live video on reference



Orthomosaic

13

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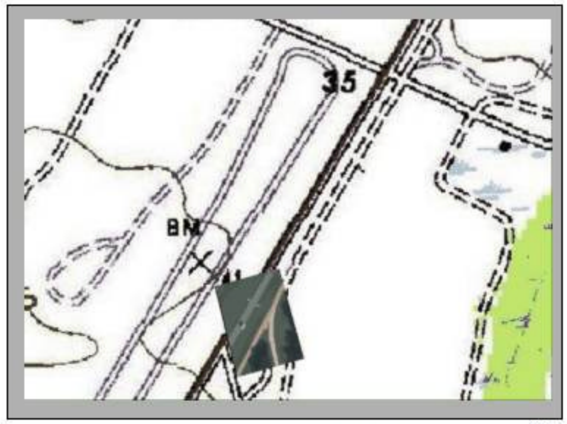
Slide 12

MTI tracks overlaid on maps
geo-coordinates tie multiple information sources together

[Video]

MTI tracks overlaid on reference image



[Video]

Video orthorectified and overlaid on map

14

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Slide 13

Adding moving objects to the model
advanced stereo provides 3D object models

Source video

Marine | Jeep | Mob

3D range from stereo

15

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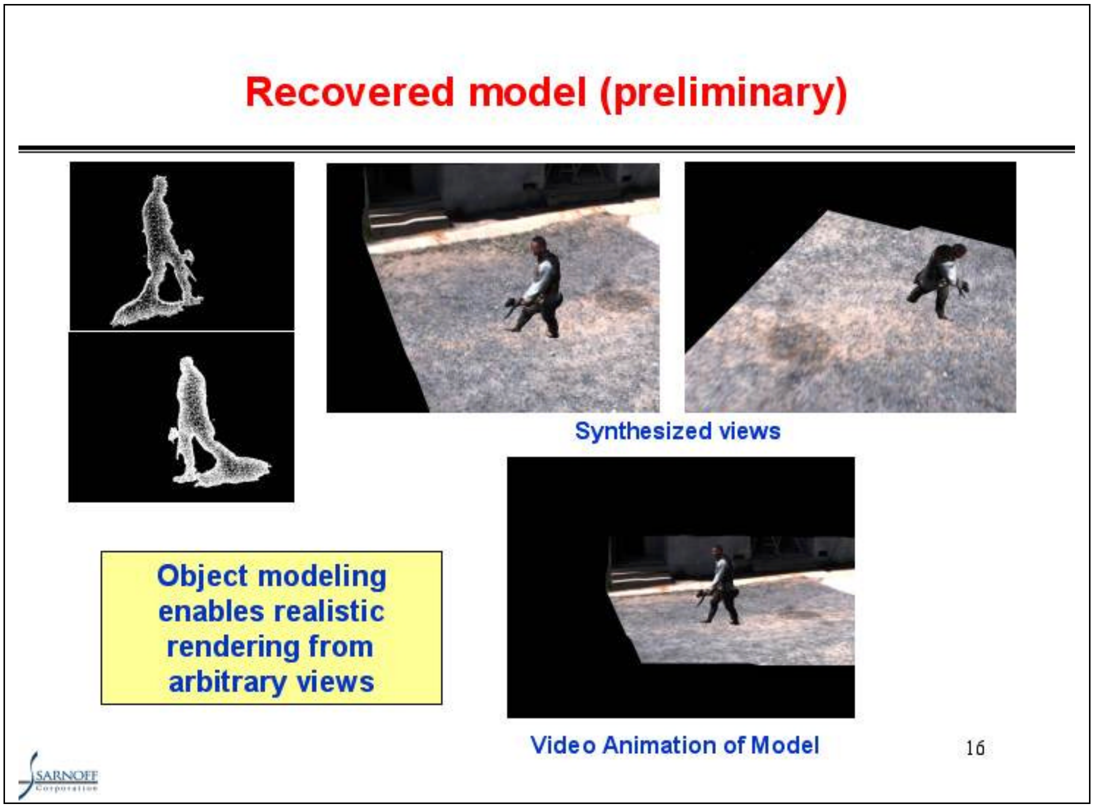
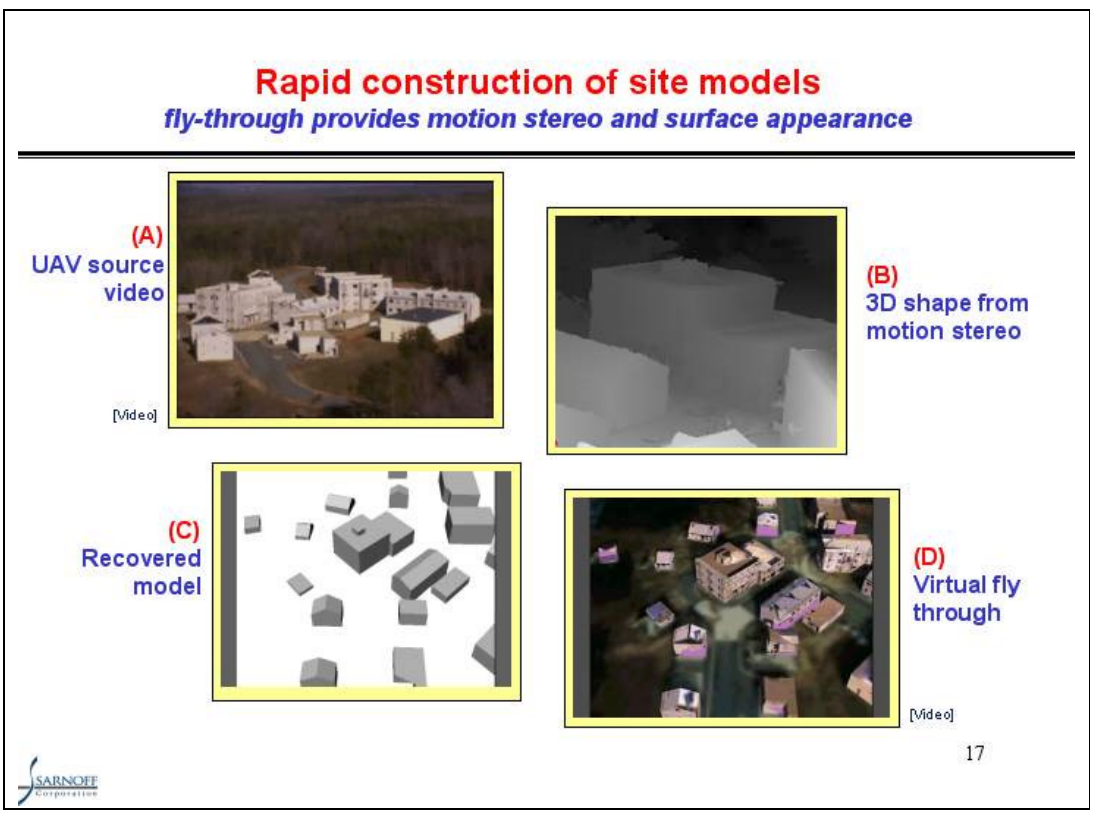
Slide 14



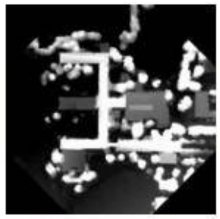
Slide 15



Slide 16

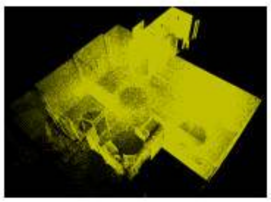
Modeling Sarnoff

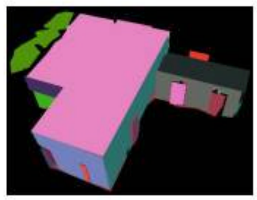

Aerial images

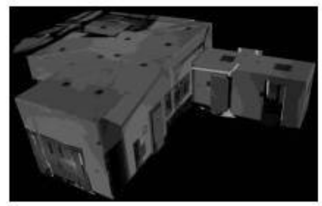

Stereo depth


Building outlines


Box model


Laser scan


Surface fit


Texture mapped

18

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Slide 17

4D Visualization for Training

ONR contract to support marine training

Program objectives

- Distribute cameras inside and outside "training" area
- Visualize activities overlaid on a 3D model
- Record and replay to analyze mission performance


Sarnoff campus, Princeton NJ

19

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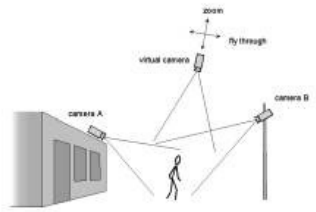
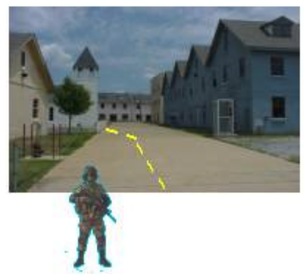
Slide 18

Summary



- Integrate all sensors into a common 4D model
- Detect and overlay activity
- Allow commander to fly through and review over time
- Project key information to the warfighter



20

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Slide 19

Force Protection Information System Program

Gordon Schacher
Naval Postgraduate School

Clifford Link
Naval Criminal Investigative Service

BACKGROUND

Post Cole incident, Pacific Fleet sponsored development of a web-based Anti-Terrorism/Force Protection (AT/FP) information system and associated planning processes. The Naval Postgraduate School (NPS), Naval Criminal Investigative Service (NCIS), and Third Fleet plan and execute Limited Objective Experiments (LOEs) to meet the program's objectives. The Office of Naval Research provided funding for the first experiment, which was executed at Port Hueneme in August 2001. This paper focuses on information system development, omitting Force Protection execution aspects of the program.

The initial phase of the program was based on the assumption that improved information is needed for AT/FP planning, with the following broad information system attributes:

SIPRNET web-based
available to units with low bandwidth and intermittent connectivity
support collaborative planning
dynamic information updates as FP execution approaches

NCIS is standing up the Multi-Threat Alert Center (MTAC) to provide improved threat information and distribution to the Navy. This program is developing the system requirements for MTAC AT/FP information distribution and processes for tactical use of that information

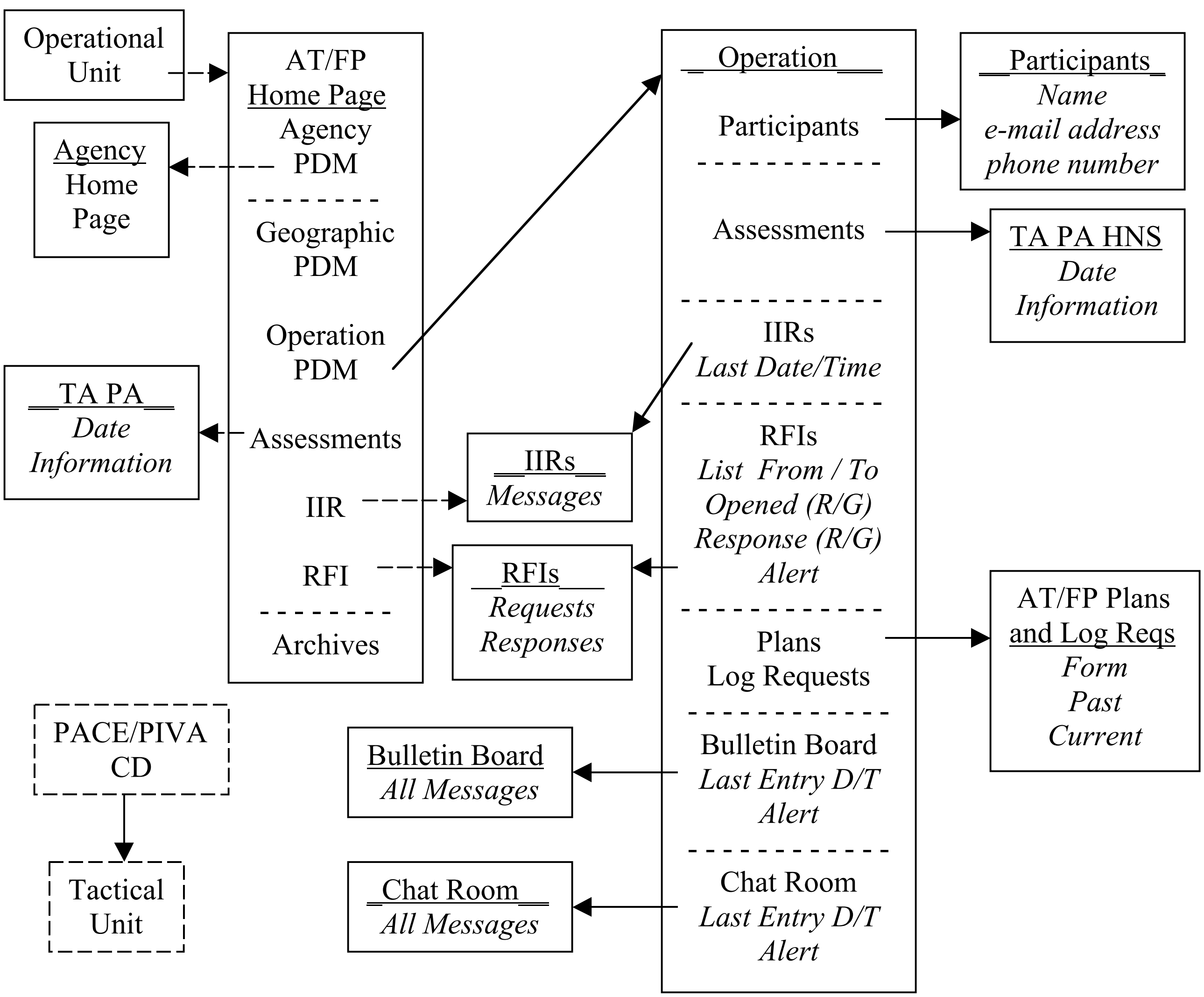
INFORMATION SYSTEM REQUIREMENTS AND STRUCTURE

The Navy has installed Collaboration-at-Sea (CaS) on most of its ships. It is a Lotus Notes based system, operates on SIPRNET, and provides information replication. When a ship comes on line, information updates are automatically replicated to its server. This capability alleviates bandwidth restrictions. There can still be information currency problems, depending on a ship's connectivity schedule.

The Tactical Anti-Terrorism Information and Planning System (TATIPS), has been developed to support this program. Its current version is being tested on a non-classified CaS server. Its main purpose is to test capabilities and develop requirements rather than produce a system to be fielded. Descriptions of TATIPS structure and the various web pages follow. Each solid box in the figure represents a web page, with arrows showing links.

The information system will be used for two purposes with slightly different paths: 1) to obtain area information (dashed arrows), 2) to obtain specific operation information (solid arrows). For both uses the initial step is a geographic Pull Down Menu (PDM). (We do not discuss here using the system to obtain historical information through the archives.) When interested in an area, one obtains information directly through the AT/FP Home Page, with the exception of operation specific information. When interested in a specific operation, e.g. a ship entering a port, one will go to that Operation page from an Operation PDM under the geographic area.

Entry to the system for an operation will normally be through the Operational Unit home page, such as that of Third Fleet. When interest is for the area rather than an operation, entry will be directly to the AT/FP home page from any originating point.



Information system structure

Web Pages

Operational Unit: Home page of the organization that has cognizance over the operation, e.g. Fleet, Region.

Agency: Home pages of the various agencies that may have pertinent information.

AT/FP Home: This is the central hub for stepping to any desired AT/FP information.

Agency PDM: Allows the user to go to a specific agencies home page for either information or communication.
Geographic PDM: A geographic area is chosen as the initial navigation action.
Operation PDM: The Menu is used to access the specific operation of interest. Each operation will have a name that easily identifies it to the user.
Assessments: Current Threat and Political Assessments for the area.
IIR: Provides access to all Intelligence Information Reports for the area.
RFI: Provides access to all Requests For Information for the area.
Archives: Files of information from past operations.

Operation: There is a separate home page for each operation. Only information for the specific operation can be accessed from this page.

Participants: Name, organization, and e-mail links of operation participants.
Assessments: Direct links to Threat and Political Assessments and Host Nation Support.
IIR: Direct link to IIRs for the area, including date/time of the last report.
RFIs: Direct link to operation RFIs, who from, to whom, whether it has been opened, and whether a response has been generated. An alert is shown for outstanding requests.
Plans: Direct link to pertinent AT/FP plans and LOGREQs, past and present.
Bulletin Board: Direct link to the bulletin board for that operation with date/time of the last entry provided. An alert is shown for entries for which a response is requested.
Chat Room: Same as the Bulletin Board.

Threat Assessments (TA) and Political Assessments (PA): TAs and PAs apply to an area and it is assumed that all will be pertinent to an operation within that area. Thus, the same information will be accessed whether navigating for the area or an operation. Each Assessment is accompanied by the date issued/updated.

Host Nation Support (HNS): HNS refers to support provided for a specific purpose at a specific location, so it is included only for an operation.

AT/FP Plans and Logistics Requests: This page contains forms for plans that are to be submitted for the particular operation. It will contain forms that have been completed and submitted for similar operations or, preferably, for that same location. The current, active plan for this operation is present. If there has been more than one plan submitted, the original plan and the current update are present. *Note: depending on the C2 process for the operation, it may be necessary to have ISIC approval before a plan can be posted on this page.*

PACE/PIVA CD: PACE and PIVA are being combined into a single product for AT/FP use. PACE is too large for many platforms to be able to access through the internet, and the same will be true for the combined product. Thus, CDs will be burned with the information and provided to units. This programs information system will provide updates to that information.

After-Action Reports (AARs): AARs will be placed in the information system archives.

Multi-Path Information

Some information must go directly to tactical and operational units. This system is not meant to replace existing communication paths, such as Navy messages. Thus, some information will be transmitted by these means as well as being posted on TATIPS. A desired capability is single-point-entry, such as automatic messaging upon entry of information to the web.

Tactical information will be generated at the operation site. An example is changes in Host Nation Support. This information will be acquired by a local agent and transmitted directly to the tactical unit Command. Depending on available time, this information may not be on the information system until after conclusion of the operation.

Alerting

Various pieces of information are time critical and an alerting system will insure they are seen and/or timely action taken. Information for which alerts are needed and the type of alert are:

AT/FP plan - due date.
Logistics Request - due date.
Bulletin Board - alert recipient of an items presence, when desired by the person posting.
Chat - alert recipient of an items presence, when desired by the person posting.
IIR- alert affected operational and tactical units and local agents.
RFI - alert request recipient, alert requestor when a response is sent.
Assessments - alert operation participants of any change in an assessment.

LOE #1 RESULTS

A fully developed information system was not available for LOE #1. The system used was a combination of capabilities from Third Fleet and Department of State, which provided an adequate test of the program's concepts. The following results emerged from shipboard personnel using this system for planning prior to the execution phase of the experiment. A full report on LOE #1 is available.

1. Manning the system to fully make use of collaboration during AT/FP planning requires more personnel time than is available.

2. The current connectivity schedule of 6 on/6 off leaves dark periods that are too long for collaborative planning.

3. Both chat and bulletin board capabilities were desired, for asynchronous and real-time collaboration.

4. Being able to contact intelligence agencies directly through the web improved planning.

5. Watch standing at the Immediate Superior (ISIC) level must match that of the tactical unit for plans iteration and approval.

6. The tactical commander needs to have insurance that the ISIC is using the same information when plans are being rapidly changed in a dynamic situation.

The most far-reaching of these results for this program are 1) workload and 2) connectivity. Excessive workload implies that a combination of directed and dynamic planning is needed. Connectivity implies that a replication system such as Collaboration-at-Sea (CaS) is needed. It also indicates that a change in connectivity scheduling is needed.

CURRENT PROGRAM DIRECTIONS

As has been noted above, this program has developed TATIPS not as a system to be fielded but one to determine requirements. This means that, at some point, a transition is needed to development of an operational system or to implement TATIPS capabilities within existing systems. We have chosen the latter course.

Three AT/FP information systems are under current development that are candidates for implementing the capabilities identified by this program. They are:

Joint Risk Assessment Management Program (JRAMP)
Area Security Operations Command and Control (ASOCC)
Integrated Warfare Command and Control System (IWCCS)

JRAMP has been developed for USEUCOM and will be mandated for use by units going into that theatre. It has been vetted by Sixth Fleet for submission of their directed AT/FP plans. ASOCC has been developed for Pacific Command and servers are currently in place. A civilian version has been developed for Coalition operations. It will be tested for use within MTAC in the near future. IWCCS is currently in use in Carrier Battle Groups for situation awareness. It is being modified by NSWC/Keyport for shore-side AT/FP use. A test of it similar to that planned for ASOCC may be undertaken.

All of these information systems satisfy some of the requirements that have been developed by the TATIPS program, but not all. This program is currently examining how to adapt to use of one, or all of the above systems. It is planned to test JRAMP during LOE #2 and ASOCC during LOE #3.

Transformation… CETO Style

Ki Harvey
Deputy Director
Center for Emerging Threats and Opportunities (CETO)

The Center for Emerging Threats and Opportunities (CETO) was established in November 2000 at the direction of the Senate Armed Services Subcommittee on Emerging Threats and Capabilities out of a growing concern for the wide range of security challenges the US will face in the 21st Century. CETO is a unique organization within the Marine Corps establishment and is best viewed as a ***think tank*** dedicated to developing new ideas. Currently CETO is addressing the following tasks:

- Develop possible futures (beyond EFDC focus).
- Alert senior leadership to new threats and opportunities.
- Stimulate the Advocacy Process.
- Focus on the long-view while recognizing the force development continuum (time).
- Serve as a nucleus of ***think tank*** for ACMC.
- Support MARFOR/MEF Commanders.

Technology is changing everything, and the pace of technological change is accelerating. Proliferation is a key issue, but it's not just that technology is available everywhere. The real key is that technology is proliferating in a way that is more and more user-friendly, and can be used as an enabler to support the adversary. Part of CETO's role is to think down the road about how the Marine Corps must organize and fight to successfully meet the challenges in future conflicts.

The current Mission Needs Statement (MNS) states that the Expeditionary Fire Support System (EFSS) must provide close supporting, accurate, immediately responsive, and lethal fires in support of the MAGTF. That drives the key issue of internal transportability and limits weight and size. The USMC must have Initial Operating Capability (IOC) in FY06. Force Structure implications also need to be examined. Finally, as we push technology forward, we need to be sure that we are smart about it.

Many adversaries in the world have access to or are actually employing enhanced effects or thermobaric weapons. The Soviets were the primary developers of these weapons and they have been proliferated to numerous other countries. The RPO-A and the RPG-7V are the primary examples. CETO discovered that very little work has been done on developing defensive tactics, techniques, and procedures for dealing with these weapons. Further, we found that not a lot has been done on medical precautions and treatment issues. In conjunction with MCCDC (Marine Corps Combat Development Command) and SYSCOM (Systems Command), we have developed a draft paper (currently being staffed) that addresses both these issues. We are also starting to work on offensive Tactics, Techniques and Procedures (TTPs). In addition, we are helping to define requirements for a confined space clearing capability.

We try to listen and respond rapidly to the evolving needs of the Marine Corps warfighting commanders. CETO strives to provide useful and focused products such as tactics, techniques, procedures, assessments, draft concepts, proposals, reports, and recommendations. CETO's organizational structure provides the capability to anticipate emerging threats… the flexibility to respond to both immediate and longer term needs. In addition to its core staff of research fellows, CETO enlists the help of consultants who have strong academic credentials in various areas of expertise, and many of whom have had recent first hand on-the-ground experience.

CETO's mission is to prevent operational and tactical surprise to senior warfighting commanders. We serve as a catalyst to stimulate thought and provoke debate on issues of significance to the senior leadership of the Marine Corps. We also provide support to the senior warfighting commanders by responding to their requests for support in areas of concern. In addition, we identify emerging threats and opportunities, and develop strategies for defeating the threats and exploiting the opportunities.

Here are our tasks (Slide 3). Alerting senior leadership to new threats and opportunities and serving as the think tank for the ACMC (Assistant Commandant of the Marine Corps) are two of the most important ones. They cover the time horizon from now to the long term future.

The diagram in Slide 4 shows how CETO fits into the new Expeditionary Force Development System (EFDS) here at Quantico. We begin with a very broad focus and look to the future to identify potential threats and opportunity. In that way, we're acting like a deep reconnaissance unit to keep the main force from being surprised.

Let's look at what might cause future conflicts. The next three slides (Slides 5, 6 and 7) contain a lot of data compiled by the US Army Training And Doctrine Command (TRADOC). Looking at the world today, there seems to be less friction between ideologies like communism versus democracy. Nation states seem to be less contentious with more countries moving toward democracy. However, there is increasing tension between state and non-state players such as the Israeli Palestinian question or radical Islam versus the fundamentalist Islamic states. The lessening of tensions between governing ideologies has allowed other frictions to bubble to the surface. These are cultural and ethnic frictions. For example, the effect of the globalization of Western culture versus the more restrictive fundamentalist societies. Technology is pervasive, even in the remotest environments. There is competition for resources such as water, food, and fuel, and then there are refugees and immigration flows.

Looking at the situation as it exists today and what others say about the future, it appears that the future is driven by three overarching trends: demographics; economics; and, technology. Here are some statistics on demographics that will likely be a cause or have some impact on future conflicts. The world population will double in 40 years with 95% of the growth in the developing world. There is a youth bulge of 15 to 24-year-olds and where such bulges occur there is a likelihood of violent upheaval. Historically, countries that experience greater than 3% annual population growth face instability.

Another interesting fact is that in the US, one of every 9.7 people was not born in this country. That hasn't happened in 150 years. The US is truly a nation of immigrants. One area of concern is urbanization. By 2020, 60% of the population will be in urban areas. Just 30 years ago, one-third of the world's population was needed to produce and distribute food. Now, it takes only 8%, so people have to go somewhere to find work. Another problem is that the disenfranchised

are becoming a bigger problems for states. What do you do with people in a constrained urban environment? The issue becomes resources like water and food. For instance, in the next 40 years, 212% more water will be required just for industrial purposes to meet the exploding population needs, and much of this will be in areas that already have water problems. The likelihood is that future conflicts may well take place in an urban environment. Technology is changing everything… and the pace of technological change is accelerating. Proliferation is key, but it's not just that technology is available everywhere… the real key is that technology is proliferating in a way that is more and more user friendly. It can be used as an enabler for your adversary. You don't need college educated people to use the technology that is out there. Further, proliferation means more than just missiles, bombs and other tools for weapons of mass destruction. It includes the brains… the nuclear, biological and chemical scientists who can provide the support to other nation states or transnational organizations. An example is the Russian scientists who were reportedly working for China, North Korea and Iran after the fall of the Soviet Union. Surprise is a big issue. The US must stay ahead, but there can still be surprises out there that we can't account for.

Here are the types of likely threats we see in the world of 2015. Regional military threats. A few countries maintain large military forces with a mix of Cold War and post Cold War technology and equipment. For example, China, Vietnam, India, and Egypt… weapons of mass destruction. This includes the potential for unconventional delivery of these weapons by both state and non-state actors. The asymmetric approach of adversaries. Regardless of the foe, state or non-state, future adversaries will employ an asymmetric approach that seeks to avoid direct engagements with the US. The foe will devise strategies, tactics, and weapons to minimize US strengths and exploit perceived weaknesses (Slide 8).

In order to anticipate and face these threats and to identify where there may be opportunities, CETO maintains a strong regional approach. This way we can also act better on the requirements of the Marine Corps components of the Commanders in Chief (CINCs). Within the four regions, Pacific, Europe and Africa, Southwest Asia, and the Americas, we look at key areas such as demographic trends, weather, and the economy. We try to identify potential flash points that may ignite crises in the future. The goal is to better understand potential regional threats and develop ways to deal with them before they become battlefield crises. CETO has performed in-depth studies on regions such as India and Indonesia, and is currently examining potential flash points in Nigeria.

In addition to the regional focus, CETO is looking at fundamental areas such as weapons technology, mobility, support sustainment and aviation technology. In particular, we are focusing on the impacts of information technology, biotechnology, nanotechnology, and power/energy on these areas. Some developments may present terrific opportunities, but also cause us great harm if they're used against us.

Here (Slide 11) is a list of current projects that we have. Part of CETO's role is to think down the road about how the Marine Corps must organize and fight to successfully meet future challenges and conflicts. We are considering developing concept papers in the Fall on several topics. One paper would explore the fitness of the basic USMC organization for combat in the 2020-2025 time frame. Questions like is the current MAGTF the right construct for the future and if not, what is, will be addressed. Another paper might discuss enhancement of the MEU capabilities. This paper would address additions to the current MEU capabilities in the five to 10 years range. Technology, equipment training, and the new expeditionary strike group concept

would be addressed. A training paper would examine the potential for improving and standardizing training in the operating forces with an emphasis on the process itself. And lastly, we would like to focus on how Marine Corps concepts such as expeditionary warfare and seabasing, complement the Joint force. As you can see, we have a plate full with just these papers.

In June, CETO hosted a seminar concerning the child soldier phenomenon and implications for US forces. Today there are some 300,000 children bearing arms around the world and they're involved in over 30 conflicts. In January of 2002, Special Forces Sergeant Nathan Chapman was the first US serviceman killed by hostile fire in Afghanistan. Reportedly he was killed by a 14 years old Afghan boy. A bullet really doesn't care who pulls the trigger. CETO's goal in this was to inform operational forces about the nature of this emerging threat and why it is nearly inevitable that Marines and soldiers will face child soldiers in a peacekeeping operation or in a combat situation in the future. We saw the opportunity to provide training to deploying forces on the threats and started a dialogue among senior officers on the rules of engagement issues before the fact, not after the fact.

You've heard a lot about this (Slide 14)… how does the Marine Corps organize, equip, and train in order to combat terrorism? What capabilities and technologies does the Fourth Marine Expeditionary Brigade (Anti-Terrorism) need to have? We've been looking into these issues. Also, how do you protect a base such as Quantico? It's got 100 square miles, some shoreline, a civilian town physically located within the confines of the base, a major interstate highway and rail lines bisecting the base, and still allow the 7000 military, 5300 civilians and 3600 military family members to do what they need to do? What complicates all this is that most people, vehicles and equipment entering the base are not threats to the installation. Here, the adversary clearly has the operational advantage. Adversaries will generally observe patterns to pick a time and place of their choosing, or attack another facility entirely.

Some of our thoughts about how to solve this daunting task, especially regarding technologies use a holistic approach. This problem will probably not be solved by one system, process, or technology. It needs to be layered and graduated. We need to be able to deal with a variety of terrain and environments. There must be no single point of failure, but redundancy with graceful degradation. Penetration of the system should not disable the system nor allow total system access. The solution approach needs to be scalable, interoperable, and must work and integrate with other military and civilian security systems (including databases, networks, and communications). And, it must include the human element… enable human behavior and complement human strengths and capabilities.

The current mission needs statement states that the Expeditionary Fire Support System (EFSS) must provide close, supporting, accurate, immediately responsive, and lethal fires in support of the Marine Air-Ground Task Force (MAGTF). The requirements for this, for reasons of internal transportability, limit weight and size. The Marine Corps must have an initial operating capability by FY06. Force structure implications need to be examined. And finally, as we push technology like an Expeditionary Fire Support System forward, we need to be smart about it.

As you can see, we are deep into a number of concepts and issues that are transformational in nature. At first glance, some of the projects we're working on seem straight forward, like providing security here at Quantico. However, we've learned that it's like peeling the layers of an onion. There's always something else underneath to think about.

CETO Background

- Established in November 2000 at direction of the Senate Armed Services Subcommittee on Emerging Threats and Capabilities
- Responsive to needs of HQMC and Marine Operating Forces -- from MEU through MARFOR
- Balance of operational and academic credentials -- staff and consultants with:
  – Current operational experience (air, ground, logistic)
  – Joint, combined, and interagency understanding
  – Geographic / Regional familiarity

Slide 1

CETO Mission

- Prevent Operational and Tactical Surprise to Senior Warfighting Commanders by assessing the future security environment in light of emerging threats and potential conceptual and technological opportunities

Slide 2

CETO Tasks

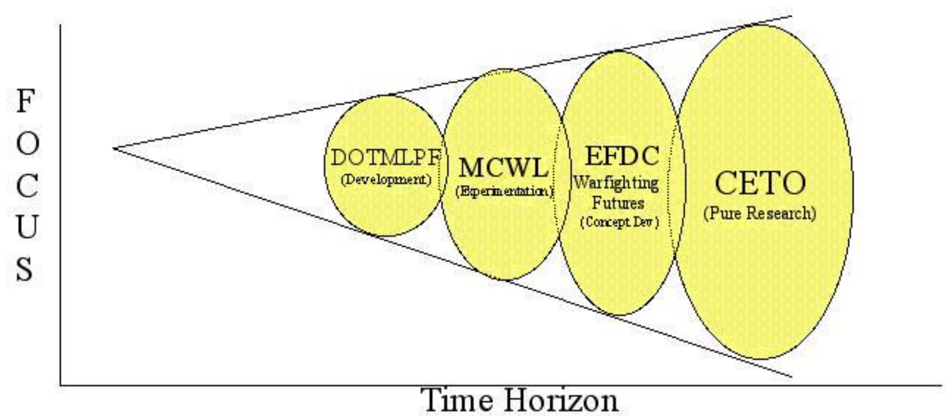
- Develop possible futures (beyond EFDC focus)
- Alert Senior Leadership to new threats and opportunities
- Stimulate the Advocacy Process
- Focus on the long-view while recognizing the force development continuum (time)
- Serve as nucleus of "think tank" for ACMC
- Support MARFOR/MEF Commanders

• Planning: The art and science of envisioning a desired future and laying out effective ways of bringing it about (MCDP-5)

Slide 3

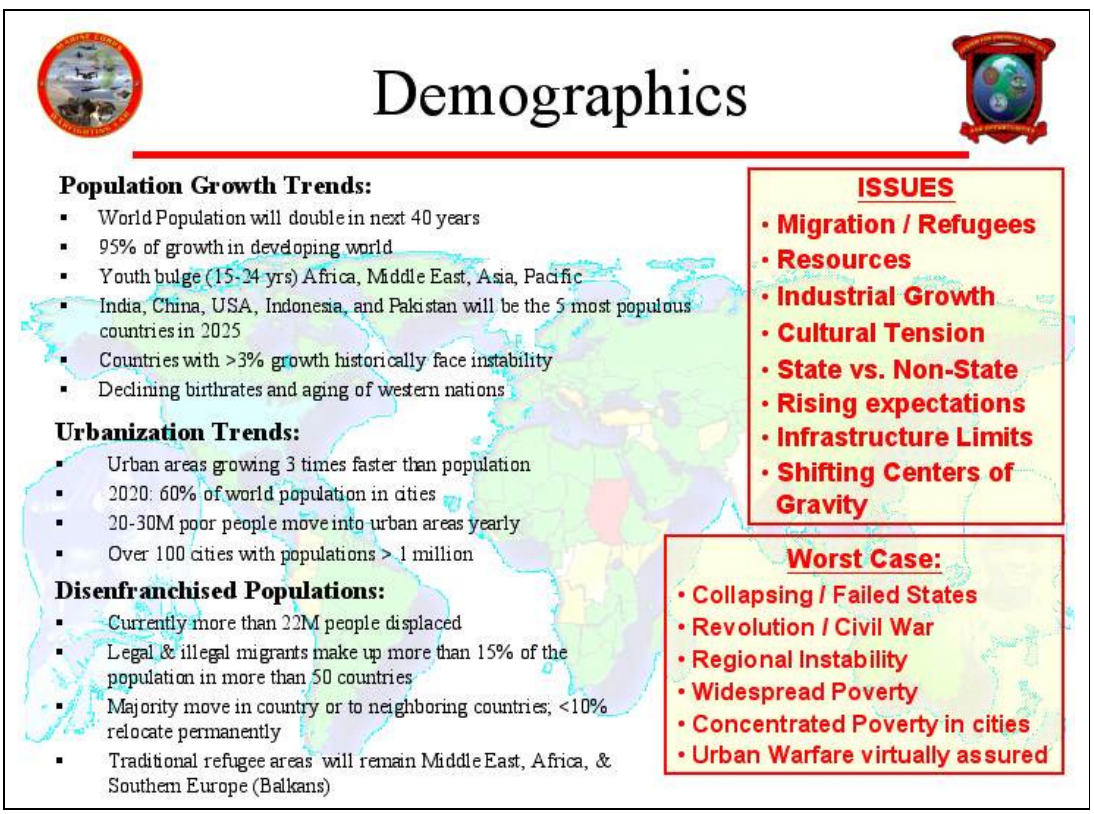
Expeditionary Force Development System

- CETO acts as the deep recon element of the EFDS



Slide 4

Slide 5



Slide 6

Technology

- 95% R&D is civilian funded
- Technological change accelerating
- Technology proliferating
  - Tied to global market
  - Internet and comms make knowledge accessible
- Information technology is a key enabler
- Dual Use R&D (Civilian / Military)
- Military effect almost immediate
  - Enhance capability
  - Negate/degrade superiority
- Biotechnology
- Nanotechnology

ISSUES

- **Technology proliferation - rapidly altering societies, cultures, and military capabilities**
- **Ability of U.S. to stay "incrementally" ahead**
- **Surprise**

Slide 7

Potential Threats of 2015

- Breakdown of nation states
- Regional military forces
- Transnational threats
- WME
- Tribal conflict
- Asymmetric threats
  - Avoid direct engagements with U.S.
  - Devise strategies, tactics, and weapons to minimize U.S. strengths and exploit perceived weaknesses

The Future Battlefield

- High likelihood of <u>close combat in urban environments and/or complex terrain</u>
- <u>Humanitarian issues</u> present across the full spectrum of conflict
- <u>Increased presence and influence</u> of Private, International, Criminal, and Non-Governmental Organizations
- Ubiquitous <u>presence of media</u> – some unfavorable to U.S. policies
- <u>Increased Global and Regional interest</u> (Alliances and Coalitions)
- <u>Advanced Technology</u> present or available . . .and a changing Military Dynamic

Slide 8

Threats & Opportunities Matrix: Geographic Focus

	Pacific	Europe/ Africa	Southwest Asia	Americas
Political/ Military*				
Demo- Graphics*				
Economy*				
Weather/ Geography*				

*Key elements to examine within geographical areas

Slide 9

Threats & Opportunities Matrix: Functional Focus

	Weapons Technology	Mobility	Support/ Sustain	Aviation Technology
Infotech*				
Biotech*				
Nanotech*				
Power/ Energy*				

*Key technologies to examine within functional areas

Slide 10

Current Projects

- Concept Papers
- Child Soldiers
- Anti-Terrorism/Force Protection/Homeland Defense
- Expeditionary Fire Support System
- Enhanced Effects Weapons (Thermobaric)

Slide 11

Concept Papers

- USMC Organization in 25 years
- Enhancing MEU Capabilities
- MEB Deployment Concept
- Training
- Joint Force Interoperability

Slide 12

Child Soldiers

- Seminar for Marine Operating Forces and HQMC with presenters from Brookings, UN, UNICEF, Human Rights Watch, UK Military Attaché Office
- Provide instruction block for deploying Marines
- Discuss potential ROE implications for military operations

Slide 13

Anti-Terrorism/ Force Protection/ Homeland Defense

Two projects:

- HQMC
  - Assess USMC organization and training for anti-terrorism and force protection
  - Assess 4th MEB (AT) mission and organization
  - Recommend technologies / capabilities for combating terrorism
- Operating Forces
  - Research / recommend technologies to improve access control and enhance surveillance / security at Bases worldwide.

Slide 14

Expeditionary Fire Support System (EFSS)

- Review EFSS MNS and identify key issues
- Develop framework for an Organizational and Operational Concept
- Assess applicability of Expeditionary Fire Technology Demonstration (EFTD) technological advances

Slide 15

Enhanced Blast Weapons

- Develop defensive tactics, teaming with UK
- Examine medical precautions and treatment issues
- Recommend defensive TTPs / medical issues for publication to operating forces
- Conduct M&S workshop to validate doctrine/TTPs
- Monitor Near-term initiatives in response to USMC Universal Needs Statement (UNS)
- Recommend offensive doctrine/TTPs for developmental programs
- Assist in Defining future requirements for Confined Space Clearing Capability

Slide 16

Transformation … to
Intelligent, Logistics Information Management

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"I don't know what this logistics thing is that Marshall keeps talking about, but I want some of it!" **Admiral Ernie King – 1942**

Abstract
"The security environment of today and tomorrow will be characterized by uncertainty, chaos, surprise, and conflict … naval forces must exploit the power of information to seize the advantage over potential adversaries, and must be postured, through technological advances, changes in organizational structures of forces, and experimentation with innovative concepts of operations, to sustain and advance broad competitive advantage." (England et al. June 2002)

As the nation continues to transform its responsibilities, global relationships, and military priorities; the events of this past year have highlighted the critical need for the timely integration of information and effective knowledge management in a post-911 climate. The US Department of Defense's (DOD) strategic vision is documented in the QDR and Joint Vision (JV) 2010/2020, which recognizes our changing global environment and emphasizes the need for information superiority, while ensuring operational interoperability among the military services and our allies. The department's future focus on the operational concepts of: – dominant maneuver, precision engagement, full-dimension protection, and focused logistics – should allow combined military forces to achieve full-spectrum/global dominance. US Naval Forces continue to conduct inter-operations with our Pacific Rim neighbors from Japan, Korea, Canada, and Australia; as a vital element of regional stability. In recent years China, Korea, India, Pakistan, Indonesia, and the Persian Gulf States have challenged this regional stability. Stability cannot be achieved without fully operational unit availability anywhere, anytime; capable of responding to varied situations and scenarios. Focused Logistics is a critical component of total operational readiness.

In order to ensure maximum fleet logistics readiness there is a need for the effective integration of disparate information, technological innovation, and focused logistics doctrine and practices. This is essential for the tracking and distribution of assets through the entire supply chain, from manufacturer to customer. Common or shared information at all DOD levels will enable the support communities to provide the logistics necessary to meet, and sustain, both strategic and tactical operations. Initiatives such as Total Asset Visibility (TAV) and the effective integration of maintenance and supply processes are critical to this success. Effective operational logistics will require the intelligent integration of accurate and timely information.

This paper discusses the need for the effective implementation of logistics information and knowledge management as we transform to focused logistics and intelligent information management.

Keywords

Decision support, logistics network, transportation, inventory management, just-in-time, financial management, information management, knowledge management

Disclaimer

The views expressed in this paper may not represent the official position of the US Navy, or the Commander, US Pacific Fleet.

Introduction

"Transformation is about more than technology … it is about innovative concepts of operating and configuring our forces, adjustments in how we train and base our people and material, and how we conduct day-to-day business … the goal of transformation is to maintain a substantial advantage over any potential adversary in key areas such as information warfare, power projection, space and intelligence." (Wolfowitz, 2001)

Modern military actions require the effective management of assigned assets, and the ability to obtain adequate resources to operate and maintain them. Within the Department of the Navy, there are numerous stovepipe organizations focusing on various elements of the resource process each with a limited understanding of the end-to-end logistics process or, more importantly limited access to meaningful information. In order to ensure that appropriate funding is available, necessary contracts are in place, repair and maintenance facilities are properly staffed and outfitted, transportation networks are robust, and personnel are adequately trained; an effective information management system must be available to decision makers.

The US Naval presence in the Persian Gulf and North Arabian Sea at the time of the terrorist attacks on New York City and Washington DC; emphasizes the value of, and highlights the necessity for; a fully capable military force anytime, anywhere. On September 12th, 2001, Admiral Thomas Fargo, Pacific Fleet Commander, stated that: "we can not continue to transfer personnel, ordnance, equipment, and supplies from one ship to another in order to meet deployment requirements". This observation was the result of US military practices that had been employed in recent years to maintain fully capable forces in those anticipated trouble spots, throughout the world, at the expense of non-deployed units. These actions resulted in, once again, allowing US defense forces to deteriorate to unacceptable levels. Attempts to forge the DOD into a more "business-like" organization failed to recognize the true nature of the Defense business. In light of the current Global War on Terrorism, the list of potential "hot spots" has increased while the number of available US Military assets has declined. As the force structure continues to change and available units decline there will be increased pressure for greater operational availability linked to the military needs of the appropriate theater commander. It is essential that our Naval forces have the right equipment and supplies, in the right place, at the right time. In order to meet this challenge, repair and maintenance cycles will need to be modified, logistics customer response times will need to be reduced, system and platform availability will need to be increased, and mission requirements will need to be satisfied.

The realignment and consolidation of stakeholders and intelligent information and knowledge management will be essential in the planning and development of future logistics requirements to meet DOD and coalition force operations.

I. Transformation … The Global Environment

"Emerging operational concepts, technologies, processes, and organizations will transform the capability of America's naval services of the 21st century to conduct multi-dimensional joint, allied, and coalition warfare. The transforming US Navy-Marine Corps team will be fully integrated into the Joint Team across the full expanse of a unified battlespace. Naval forces will provide unique and complementary warfighting capabilities from the sea to joint force commanders to support their ability to enhance deterrence; secure swift, decisive military victory; and strengthen the peace that follows in support of the critical operational goals outlined in the 2001 Quadrennial Defense Review and the Secretary of Defense's Defense Planning Guidance." (England et al. 2002)

It's been said that militaries are always prepared to fight … the last war. During the American Civil War, Union and Confederate commanders were still ordering Napoleonic charges long after it should have been obvious that the winning tactics at Waterloo wouldn't work at Gettysburg. Victors seldom learn the lessons of the pervious war. New threats require new defenses, new methods, new equipment, and just plain new thinking.

During Granada, US Army ground forces were not able to share information with a sister service and a quick thinking soldier relied on simple logic and conventional means of communication to avert the potential of significant personnel casualties. The US Congress recognized the need for change and in 1986 passed the DOD Reorganization Act, commonly referred to as Goldwater – Nichols. Since that time the DOD has made some progress in service interoperability, however the current administration has placed renewed emphasis on *Transforming* the military in a changing global environment.

Today we must be prepared to engage in a full spectrum of Military Operations Other than War (MOOTW). Prior to 911 global events highlight the Navy's role in humanitarian disaster relief, non-combatant evacuation operations (NEO), peace support missions, enforcement of embargoes and no-fly zones, drug interdiction, illegal immigration, international criminal activity, and rapid response to terrorism. At the time of the attacks on New York and Washington D.C. our forward deployed naval presence proved the value of a mobile combat-ready force. Global dynamics will require, the identification and availability of resources needed to fight and win or deter and protect; will necessitate a greater independence, while working more closely with those nations that are true allies.

US Naval vessels are sovereign assets that because of their mobility and self-sufficiency can relocate to any region on short notice. As the current administration has moved forward with the GWOT the need for coalition support and interoperability has increased. Command ships provide valuable independent and mobile assets that do not require partnership, agreements, or treaties with regional governments in order to maintain a presence. Our future will require

maximum flexibility to counter threats and aggression and we must be prepared to modify our plans in the backdrop of a dynamic operational environment.

In order to provide the warfighter with the maximum number of options the DOD must have a well defined, trained and ready force, whose capabilities are understood and can respond when required. As resources become scarce the force structure must become more flexible in order to respond to increased missions. In the US Navy this has resulted in fewer platforms being built and available, while adding weapons or mission response capabilities to those platforms. Add to this the challenges of being prepared to meet any mission on a moments notice, ensuring increased system reliability, maintenance and support for current equipment, systems and personnel; there is an increasing need to ensure that we optimize the resources and remain focused on the mission. While platforms and weapons systems are needed to meet current and future challenges, we must ensure that these systems are fully operational when required stressing the need for an effective balance of current and future force requirements. Deputy Secretary of Defense Paul Wolfowitz recognized this fact in his April 2002 testimony to the Senate Armed Services Committee Hearing on Military Transformation

In order to ensure material availability we must identify and equipment required to meet the current and future threats to global security, the Department of Defense must evaluate all potential threats and analyze the resources required to neutralize, minimize, or eliminate those threats. We must also recognize that previous defense strategies may not work in the future. As an example we can no longer count on our strategic forces to deter a foreign power from a first strike attack. Likewise, increased use of chemical and biological weapons by military, para-military, and others is an indication of vulnerability which places new demands on governments to provide protection for the general population. Finally, the increasing complexities of an urban battleground add to the need for a greater balance of requirements to resources and the essential availability of real time knowledge to maximize the warfighter's options.

Figure 1. depicts the roles, responsibilities, organizations, and focus of the logistics readiness equation.

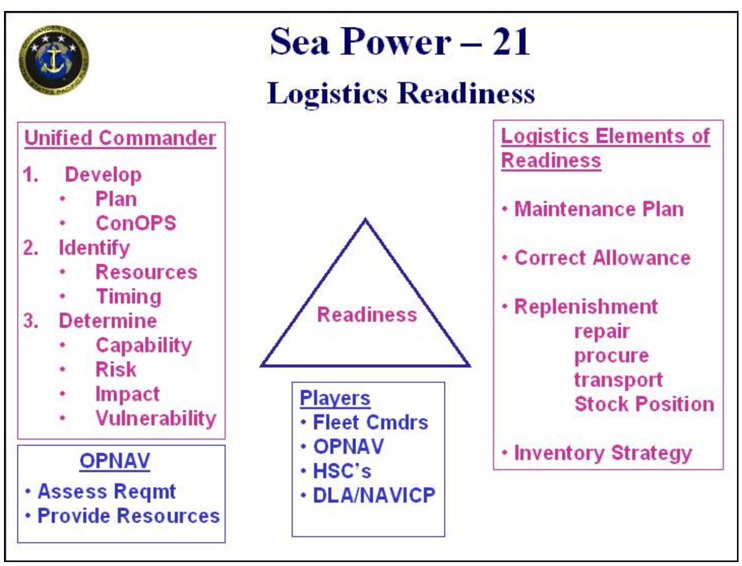

Figure 1. Logistics Readiness to support Sea Power – 21

The unified commanders have the principle responsibility of developing plans and concept of operations in order to counter anticipated threats. Additionally, the development of these plans require the identification of the required resources and the timing for their availability. Finally, the commanders must determine the capability required, the acceptable risk, the impact of their plans, and their vulnerability or weakness.

Once the unified commander has developed the plans and identified the resources required they must convey the requirement to the Chief of Naval Operations, who is the administrative agent responsible for assessing the requirement, and submitting the support documentation to obtain and distribute the resources.

Logistics readiness requires the development of maintenance plans to ensure equipment and facility availability. These maintenance plans are the responsibility of the engineering community and the Navy's Hardware Systems Commands (HSC). Once these plans have been developed the logistics community must assess the acceptable customer wait time in order to determine the proper material/parts allowances the stock positioning of the material, the transportation network's ability to provide the material when required, the lead time to manufacture the material, and the ability to repair existing components in order to maintain adequate ready-for-issue inventory levels. This effort requires the effective communication of numerous logistics readiness stakeholders; including the Fleet and Type Commanders; and the OPNAV, HSC, and inventory support staff.

History has proven that global relationships are dynamic. A review of our allies and enemies over the past 226 years provides evidence of this constantly changing environment. We must be prepared to respond wherever and whenever required. Military preparedness will demand that adequate logistics support is available in order to execute our plans. Therefore it is essential that we bring together personnel, supplies, and equipment in a coordinated and responsive manner to meet the demands placed on the logistics network.

II. Transformation … Focused Logistics

"*Focused logistics integrates information superiority and technological innovations to develop state-of-the-art logistics practices and doctrine." (Cohen 1997)*

In order to meet the challenge of change we must be able to sustain a long-term, forward deployed presence. Within the Pacific Fleet this can mean supporting deployed forces through the discipline of sea-based logistics with a full spectrum of battle force replenishment, operational logistics, weapons handling, force support, maintenance, and infrastructure from logistics bases over 14,000 NM away. These disciplines include the challenges of: conducting re-supply in sea state 3 conditions, Total Asset Visibility (TAV), providing logistics information to operators, safe knowledgeable weapons handling, stock positioning, transportation, re-supply and predictive maintenance actions.

The area of logistics brings together the disciplines of staffing, training, warehousing, inventory management, transportation, procurement, repair, and maintenance. While most requirements

can be satisfied by financial resources, there may be some instances where the availability of financial resources alone will not allow actions to be taken within the desired timeframe. Therefore, it is essential that an effective information/knowledge management system be available to meet the demands of a complex logistics network.

Although funding is required to meet the DOD's goods and services requirements … dollars don't fix broken systems … material and people do. It is important that we turn our attention to material requirements and the resources necessary to have the right material, in the right place, at the right time.

Figure 2 identifies the complex logistics structure and challenges of maintaining an adequate balance.

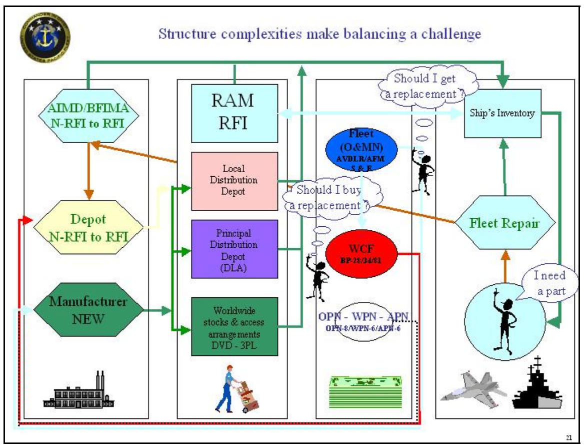

Figure 2. Logistics Structure Complexities

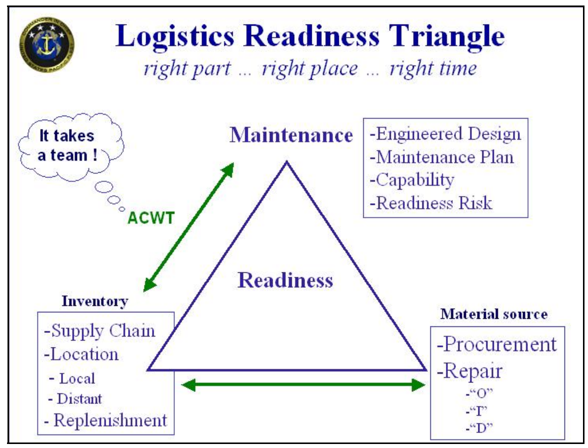

Figure 3. Logistics Readiness Triangle

Figure 2 contains four columns representing the manufacturing or repair communities, the shore infrastructure inventory warehouse or storage facilities, the fiscal management communities (both inventory and cash accounts) of the various stakeholders, and the shipboard and aviation platforms or customer base. As indicated there are numerous, special interests, and stakeholder relationships which require effective communication in order to maximize options and enhance the effectiveness of the decision making processes. Roles and responsibilities vary from one stakeholder to the next and many of the business rules and processes that exist today are the result of isolated stovepipe organizational decisions.

Figure 3 depicts the three principle elements of the logistics readiness triangle required to maximize the Navy's opportunity to have the right part, in the right place, at the right time. The key points to be made are that it takes a team effort and the amount of Acceptable Customer Wait Time (ACWT) is a metric that must come from the person or organization that is responsible for fully operational equipment and systems. Critical to team performance is knowing what needs to be available, when it is required, by whom, storage location, and our ability to deliver the good or service.

Inventory managers may desire to locate material in strategic locations, however the uncertainty of mission requirements and equipment necessary to support those missions requires the timely availability of material or equipment assemblies and sub assemblies. Post-911 there were

periods of time when the existing transportation system could not deliver material to the customer. Uncertainty regarding material failure rates, and organic repair capabilities further complicate the logistics readiness equation. From a 24-7 preparedness perspective our units would be best suited to carry all anticipated material with them. This solution may not survive the budget ax or be supported by shipboard storage capacity therefore, the stock positioning decisions require the collective integrated solution of all the appropriate stakeholders.

A study by navy inventory managers found that it takes an average of 39.4 days for a repairable item to be received at the designated repair site. The proposed solution, developed by a logistics stovepipe organization, without the participation of the fleet customer, utilizes express air freight services from the commercial contract transportation network. This solution fails to acknowledge that the customer is extremely mobile, and may have already contracted for government transportation to move passengers, equipment, or other supplies to the same location. We must recognize that capabilities which exist today in the private sector may not be available in the future. Modern *Just in Time* inventory management practices in private sector work best in fairly stable production processes, but tend to break down when used in a more dynamic environment. (Noreen and Garrison 1997).

In order to ensure that material is available to the customer, whether in maintenance (a repair part) or as a consumable (food, fuel, paper towels), warehouse and inventory management personnel must be knowledgeable of future demand. If a ship consumed $546,000 in fuel during underway operations last month but is going to be inport for the next six months there is little need to warehouse a large quantity of fuel. Inventory managers and procurement agents need to know ships operating schedules in order to ensure proper material is available either from on-board inventory or government/commercial sources. Likewise if the Ships Engineer is planning to clean the fuel storage tanks, the inventory manager needs to ensure that he can remove or not replenish fuel out of or into that storage location.

Essential to effective inventory management is the ability to evaluate and predict future requirements. Prior demand history may provide a good starting point for the 75% solution however, greater predictability is required in order to ensure proper decisions are made. It is equally important that we have accurate and unbiased information. As previously stated there are two major categories of material, repair and consumable. There is little flexibility in obtaining new consumable items, one must go to the manufacturer; but there are several options available to our modern military forces with respect to repairable items. Historically, the navy has recognized three levels of repair and maintenance; Organizational (O), Intermediate (I), and Depot (D). When we consider which level of repair/maintenance is appropriate, we evaluate the performing activities capability to complete the task. Typical limiting factors are the lack of; skill, material, facility availability, equipment, or knowledge. In order to repair system components or maintain systems we must understand the meantime between failure, the significance of the casualty, the length of service of the affected component or system, and the anticipated replacement/service life.

In a 2001 review of different Naval Aviation supply parts it was determined that of the 164,000 parts managed by Navy, 124,000 of those items had zero demand from all Naval sources (Navy, Marine Corps, and Naval Reserve). The ability to effectively predict which items will have a

demand from one year to the next will have a significant impact on the Navy's ability to increase material availability.

The numerous and varied stakeholders have over time created stove pipes that tend to isolate one another. We can not afford, from both a fiscal and readiness perspective, to allow the current stakeholders to operate in a stand alone environment. We must bring these diverse efforts together to ensure the Navy's overall capabilities meet the needs of the Commander-in-Chief and the country. A crucial element of this imperative is effective and responsive logistics information management.

III. Transformation … to effective Logistics Information Management

" Initiatives such as Joint Total Asset Visibility and the Global Combat Support System will provide deployable, automated supply and maintenance information systems for leaner, more responsive logistics." (Cohen 1997)

As identified in the previous section there are numerous isolated organizations contributing to the availability of material to our warfighters. When this problem is expanded to include the entire DOD the challenges are increased. If we are to maximize our options and take full advantage of the transformation movement within the department we must work together. Our decision makers desire to make the best possible decisions therefore, the services must effectively share logistics information and data. Without meaningful and timely data/information our decisions may fall short of our expectations.

Figure 4 provides a conceptual design to bring together information from the various communities including: financial, maintenance, operations, inventory management, transportation, vendors, and support infrastructure. A common or shared vision, throughout the department, is essential if our information/data capture methodology is to be useful and meaningful to the varied and diverse users of the systems.

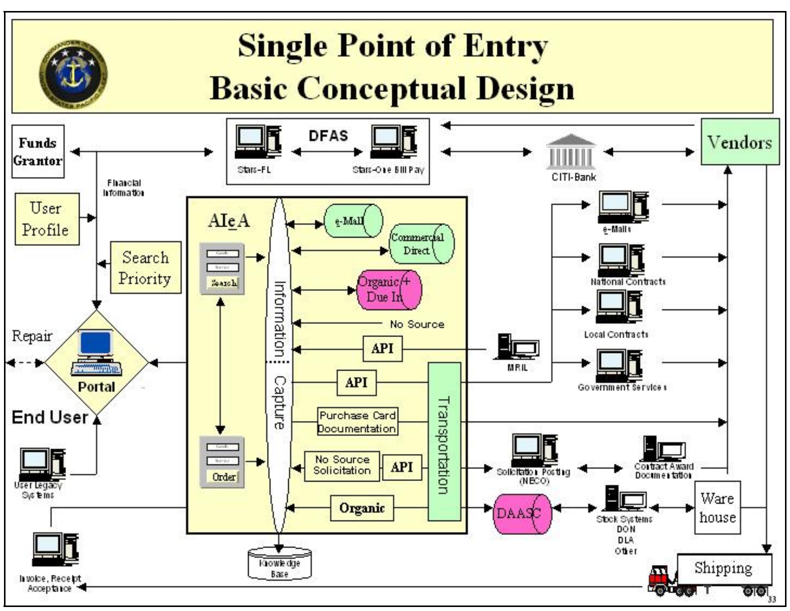

Figure 4. Logistics Information Basic Conceptual Design

Much of the required infrastructure already exists. The challenge is to create a vision that is endorsed by the stakeholders and the commitment to support and deliver the product. Members of congress and the DOD recognize that we can not achieve transformation if we are not willing to change the way we do business and if it takes an inordinate time to complete the effort (SASC 2002). Currently there are over 7,500 software applications used within the navy. Many of these systems have been developed by Central Design Agents (CDA's) whose mission includes the delivery and maintenance of legacy applications. Within the past year a fleet request to one such agent, for data base elements and schema was passed down 5 layers of the organization and after over 6 months elapsed time the information has still not been received. In order to move forward and minimize the negative effects of time delays, information must be made available to all appropriate users when desired/required. An effective balance of push/pull capability and information filtering is essential in this period of transformation.

Figure 5 depicts a network on logistics information which when captured could be available to all users. The basic network is in place therefore the information could be made available to the appropriate user without significant effort. The user community should include all elements of the logistics readiness team previously depicted in figures 1 and 3. In addition to the customer/user base depicted in figure 4, figure 5 adds elements of the mobile logistics support force and other units in an afloat Battle Group (BG), Amphibious Readiness Group (ARG), or Expeditionary Support Group (ESG).

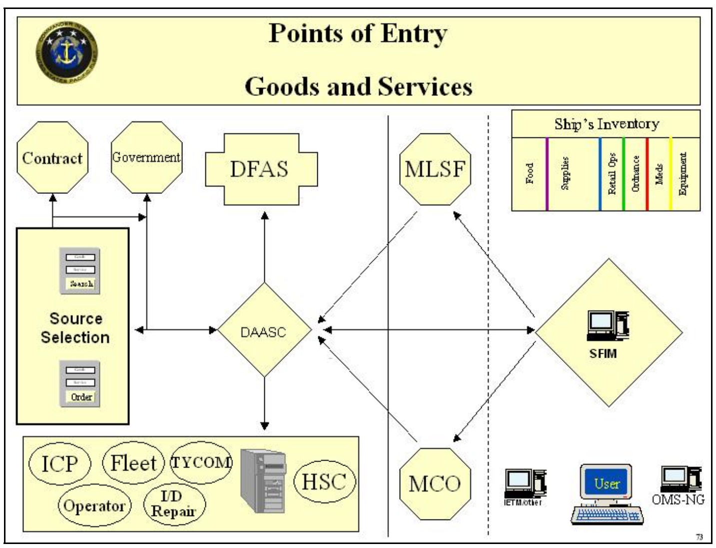

Figure 5. Goods and services information network

In an environment of increasing threats and limited resources stakeholders and legacy systems must be consolidated in a network designed with a strategic focus and a common solution. The Defense Reform Initiative Directive #47 (DRID 47) identified the need for the DOD to operate in a shared electronic data environment. The final report identified the need to effectively integrate knowledge based solutions in a seamless exchange of information (Hambre 2000).

Michael Isikoff in his Newsweek article of May 2002 observed "So much intelligence comes in, rumor, hearsay, disinformation, so little of it more than trash: once in a blue moon an agent-prospector may get lucky. But even then an agent's warning is likely to be dismissed as what

Condoleeza Rice last week called "chatter" …there's always too much information" (Isikoff May 2002). Likewise Fareed Zakaria made the following observation: "No one person at the FBI had responsibility for strategic analysis, connecting the dots" (Zakaria May 2002)

The US Department of Justice has been transmitting homeland security information to over 18,000 law enforcement agencies at all levels of government since September 11, 2001. In the months that followed the attacks on New York City and Washington D.C. information from a plethora of sources became available. Had we possessed the capability to "connect the dots" we might have been able to make some different decisions or take specific actions to offset the attacks. In our data/information rich environment we need the ability to not only access the information but to filter it and quickly analyze it to support better decisions. The intelligent use of information through integration, can ensure that we focus on the meaningful and valuable information and manage our resources in a more effective manner.

IV. Transformation … to Intelligent Logistics Information Integration

"For the past 20 years the US military services have suffered under the limitations of stove-piped computer software applications that function as discrete entities within a fragmented data-processing environment. Lack of interoperability has been identified by numerous think tanks, advisory boards, and studies, as the primary information systems problem." (Pohl 2001)

In his paper "Information-Centric Decision-Support Systems: A Blueprint for 'Interoperability'", Dr Jens Pohl highlights the importance of creating a decision support collaborative environment where computers can focus on the functions that they perform best, and humans can cooperate in the decision process with the requisite knowledge to optimize the solutions. Better decisions can be made once the human computer partnership has been established and organizations have progressed to an environment of Business Intelligence which brings together effective, computer-assisted (agent), information management and knowledge building (Pohl 2001). In an Information-Centric environment it is possible to create an architecture that will enable data-centric applications, like many of the US Navy legacy systems, to information centric systems through translators. (Fig 6). This has the obvious advantage of transforming data-centric systems, developed though the numerous stovepipe software applications, without the need to standardize data elements across the user community. As Pohl points out existing legacy applications have been developed and deployed at enormous investment. Their value is linked to the critical functions they perform, and the savings in lost time and productivity which will occur as these functions migrate to the new decision support environment. Finally new information centric systems provided under the umbrella of Enterprise Resource Planning (ERP) will require process and software changes to integrate with residual information management systems.

The cornerstone of the ERP process is the migration of numerous legacy information systems to standard applications using common data elements across all business applications. Current estimates are that the ERP process will take 8 to 10 years to complete and will cost the Navy in excess of $1.8 billion. Although ERP offers the opportunity to bring data together in a common environment it lacks the ability to identify information that could be valuable to a human-computer partnership. More important is the amount of time that it would take and the number of legacy system owners that will be required to willingly participate in the transition/migration process.

Intelligent decision support agents can help resolve both of these concerns. Agents can be created to access legacy applications and link common data elements together. The development of these agents can reduce the amount of time required to enhance the knowledge level of the users and extend the value of legacy systems.

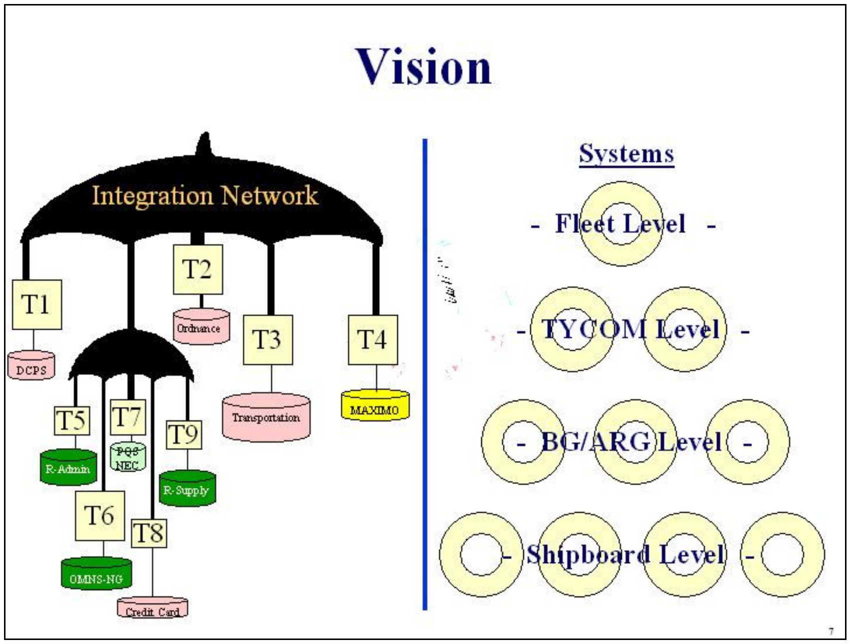

Figure 6. Logistics Information Integration Vision

Figure 6 depicts a series of translator and agents extracting data from various logistics legacy applications. The larger umbrella on the left conceptualizes the ability of integration networks to be developed in a manner which would allow them to function with other networks. From a fleet perspective the development of a system of networks would allow all layers of the organization to extract the same source data and convert it to decision support tools that would meet diverse mission requirements and responsibilities.

Figure 7 shows a more detailed perspective of logistics system integration at a unit or command level.

Figure 8 provides a conceptual perspective which brings together the repair, supply, and inventory functional areas from 3 separate organizational levels. The network to the right depicts a centralized information source that would be feed through a series of agents serving to communicate with various user communities.

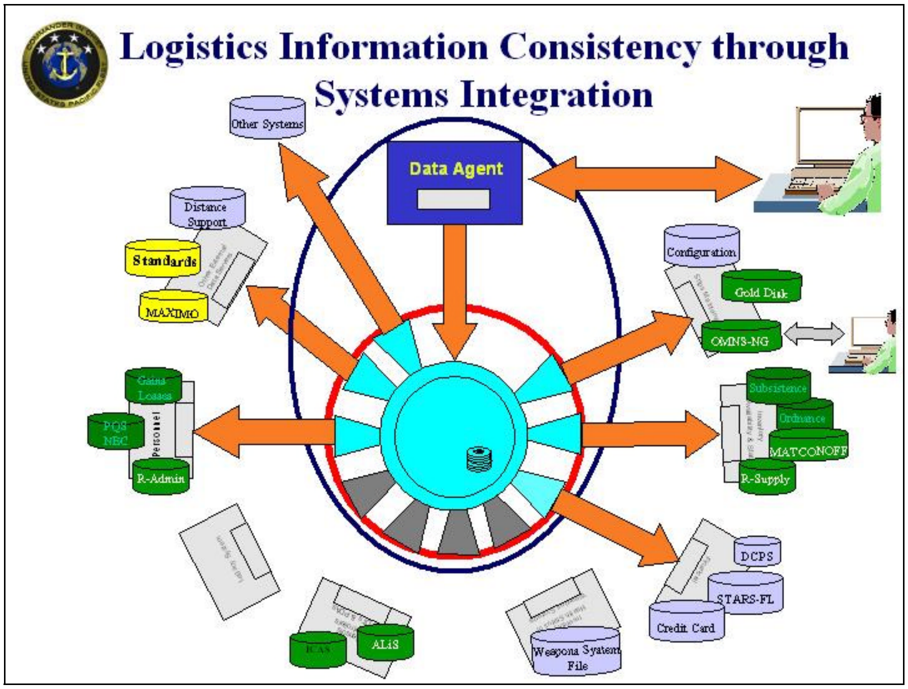

Fig.7: Logistics Systems Integrations through translators and agents

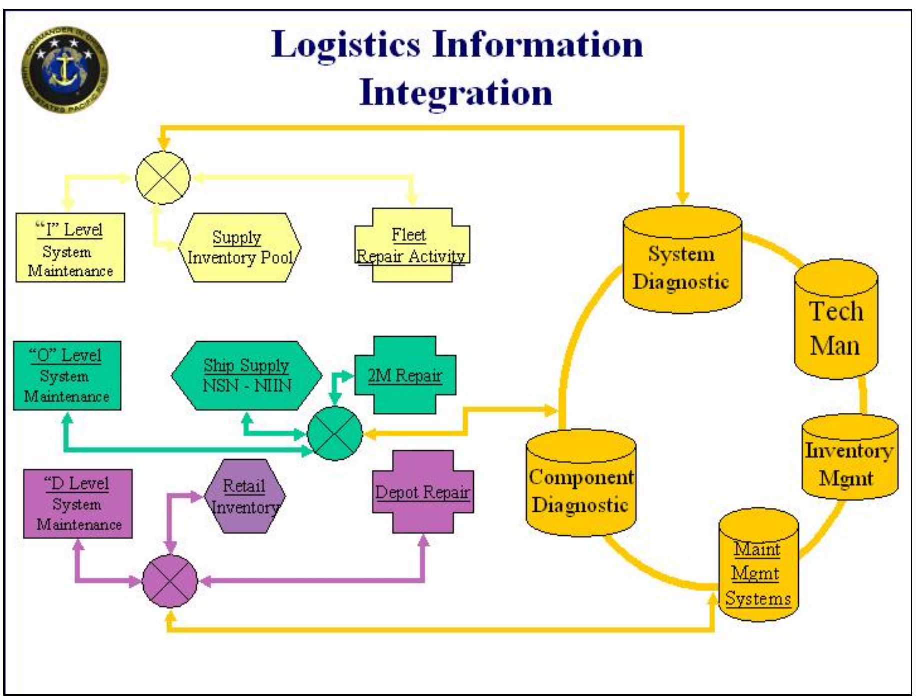

Figure 8. Logistics Information Integration

Figure 9. displays an information network that ties together the key logistics elements of fleet operations with the capability to focus on the critical information in the decision making process. An effective, integrated, and intelligent network of logistics information systems will bring

together common information in a shared environment which will permit stakeholders to meet their responsibilities while ensuring the commonality of the data/information source.

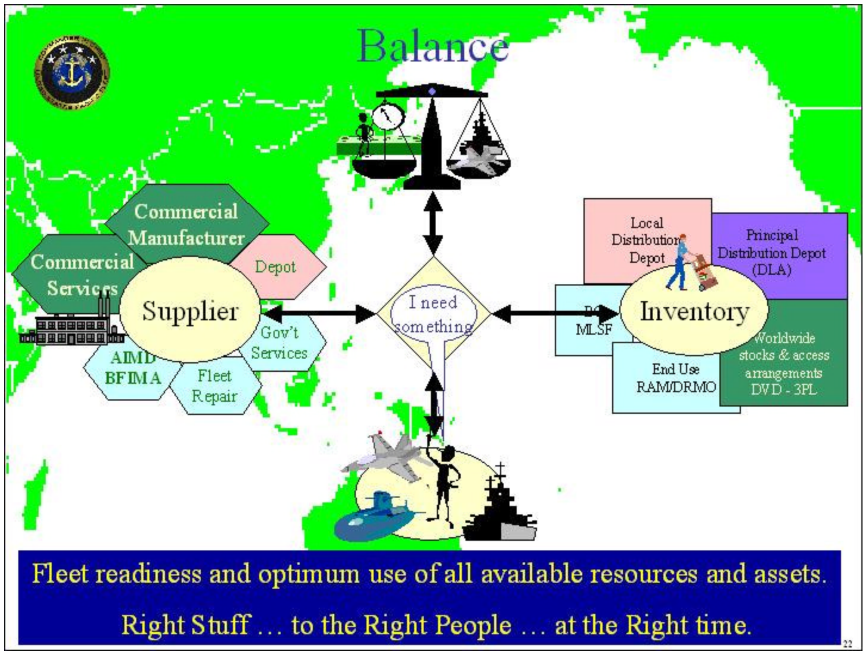

Fig.9: Achieving a Balance

Once this network is in place, collaboration can occur and communities of practice can come together to support decisions based on related functional information. This highlights a streamlined organization and information network that allows for true collaboration to occur with the numerous and varied stakeholders each empowered to make the best possible decisions based on information availability and knowledge.

V. Summary

"The significant problems we face cannot be solved with the same level of thinking that created them." Albert Einstein

People - As Deputy Secretary of Defense Wolfowitz noted in his testimony before the Senate Armed Services Committee, the single greatest element of Defense Transformation is the all volunteer force. We are experiencing unparalleled enlistment, retention, and reenlistment rates. Our military personnel are more capable and adapt at utilizing current technology than ever before. They have grown up in the information age, with keyboards and mouse's as extensions of their fingers. If we don't provide them with tools that are useful, functional, and technologically current we will lose these powerful force multipliers to private sector.

Threat - We ***must*** take advantage of the information that is available within the DOD and utilize the technology available in private and academic communities if we are to exploit Information Technology and move forward. As we develop our plans for the future we need to look at what functions should be done in house and what functions should be outsourced. In that

light, it is essential that the department correctly assess the threat, create a strategy to counter that threat, and develop the plans necessary to execute the strategy. This function is *inherently governmental* and should be done by government military or civilian employees. If we fail to plan develop and implement with the appropriate mix of stakeholders we will not be able to respond as required. History has shown that we don't have to wait 16 years to deliver acceptable products if we work within the organization and seek out *pockets of innovation*.

Information - Today's demand for meaningful and valuable information will not allow us to wait for the data/information owner to provide us with the information … we need tools that are user-centric which will allow us to gain access to information when required. From a technological perspective there is no longer a need to rely on stovepipe organizations to pass data/information to the user community. The real challenge will be overcoming the information protectionist policies of legacy information owners. The advent of *Agents* provides us with the opportunity to intelligently integrate data and information. In order to expedite the information/knowledge management process we must exploit our pockets of innovation and develop a strategic blueprint for intelligent information management.

Logistics - Focused logistics will require the cooperation, communication, and interoperations of our allies and sister services. It is essential that the 4 elements of logistics and supply support are brought together to focus on material availability. This will require material manufacture, repair, storage, stock replenishment, and transportation; based on the best information available to all the organizations involved in the process. With increased availability of information and the intelligent use (filtering) of that information to all organizations and individuals involved; we will be in a better position to ensure material, equipment, and personnel availability. Within the DOD each of the services are taking a different approach to the logistics support/material availability strategy. In some cases material support will be 100% contractor supported, while in other cases there are plans to allow the manufacture of material "on-the-fly" providing mobile manufacturing capability and an inventory of raw material. If we are going to transform the DOD we need a department level strategy that recognizes the interdependence of our military services.

Transformation

We can not wait 10 to 20 years to deliver major weapons systems, we must figure out how to bring systems on line faster. (Wolfwitz 2002). As Vadm Cebrowski pointed out in April 2002 during testimony on military transformation; change does not have to take this long, proof shows up again and again in our history. For example, the go-a-head for the Polaris missile program was given in November 1956. Just 48 months later, the USS George Washington – our first Polaris missile submarine made it's first patrol. Our Navy's strategic program has been uninterrupted since. The program has been flawless because of the vision, commitment, cooperation, and teamwork of dedicated personnel and organizations.

As Naval Commanders seek to create balanced programs it is imperative that the future realities of uncertainty, chaos, surprise, and conflict be kept in perspective, we must focus on our collective missions and never lose sight of the importance we play in support of our National Security Strategy. **Failure is not an option!**

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Hambre, J.J. (1999): Department of Defense Reform Initiative Directive (DRID) # 47: End-to-End Procurement Process

Pohl, J (2001); 'Information-Centric Decision-Support Systems: A Blueprint for 'Interoperability'', ONR Workshop on Collaborative Decision-Support Systems, Quantico, VA, June 5-7 (pp. 35-49)

Hirsh, M., Isikoff, M, (Newsweek May 27, 2002): Al Qaeda

Zakaria, F, (Newsweek July 8, 2002): Freedom vs Security

The Future of Training and STOW
(Synthetic Theater of War)

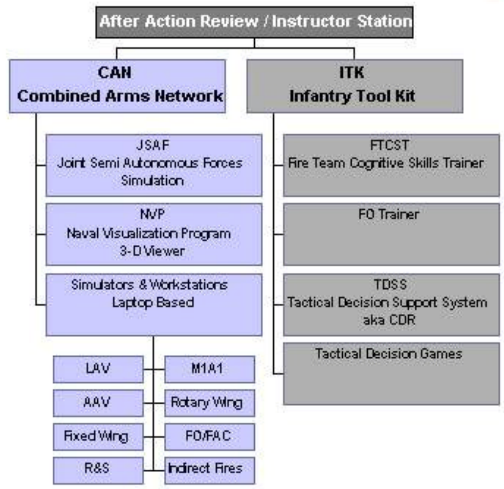
Dr. Michael P. Bailey
Technical Director
Training and Education Command
MCCDC. US Marine Corps

Deployable Virtual Training Environment

DVTE: A Unique Set of Tools

DVTE is a collection of tools specifically designed to provide deployed Marines with the ability to sustain specific unit, team, and individual skillsets

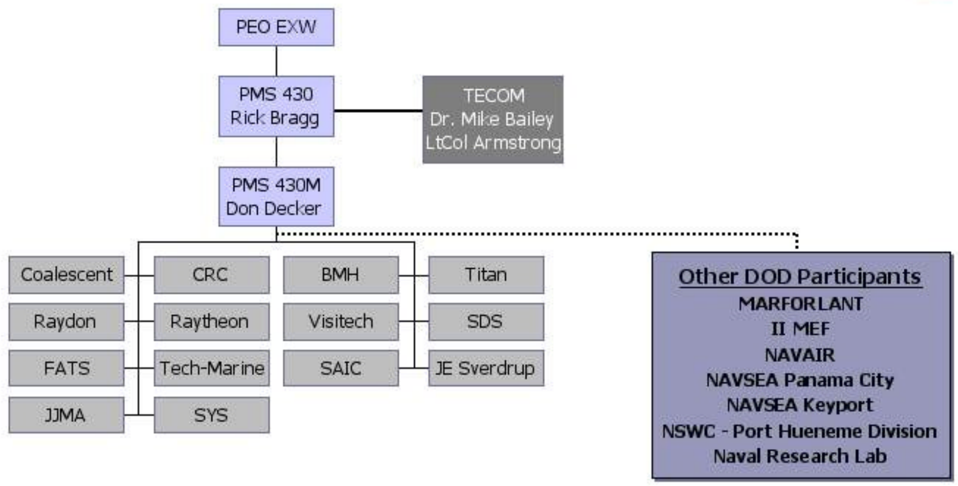
DVTE consists of a network of reconfigurable laptop computers capable of running any DVTE application



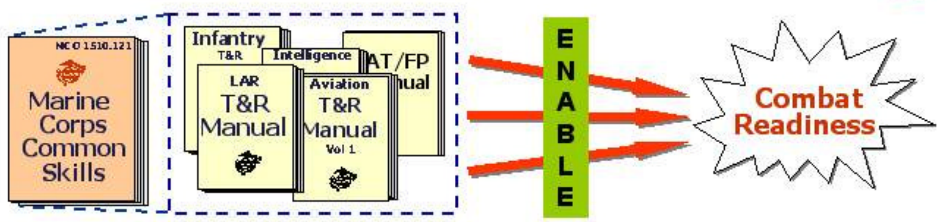
Example Skillsets Trained

Staff Training	Unit Training	Team Training
Command & Control	Combined Arms Training	Squad & Fire Team Tactics
Fire Support Coordination	Small Unit Tactics	Teamwork skills
	Teamwork skills	Leadership
		Individual Decision Making

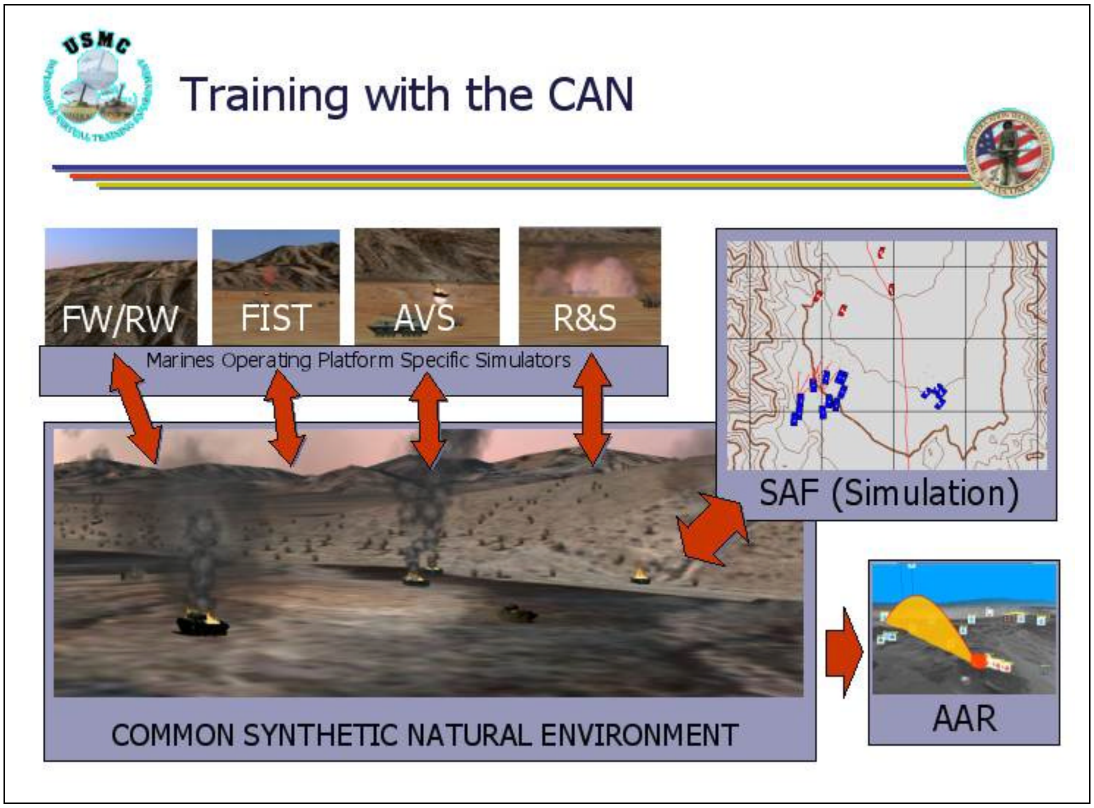
DVTE Program Structure



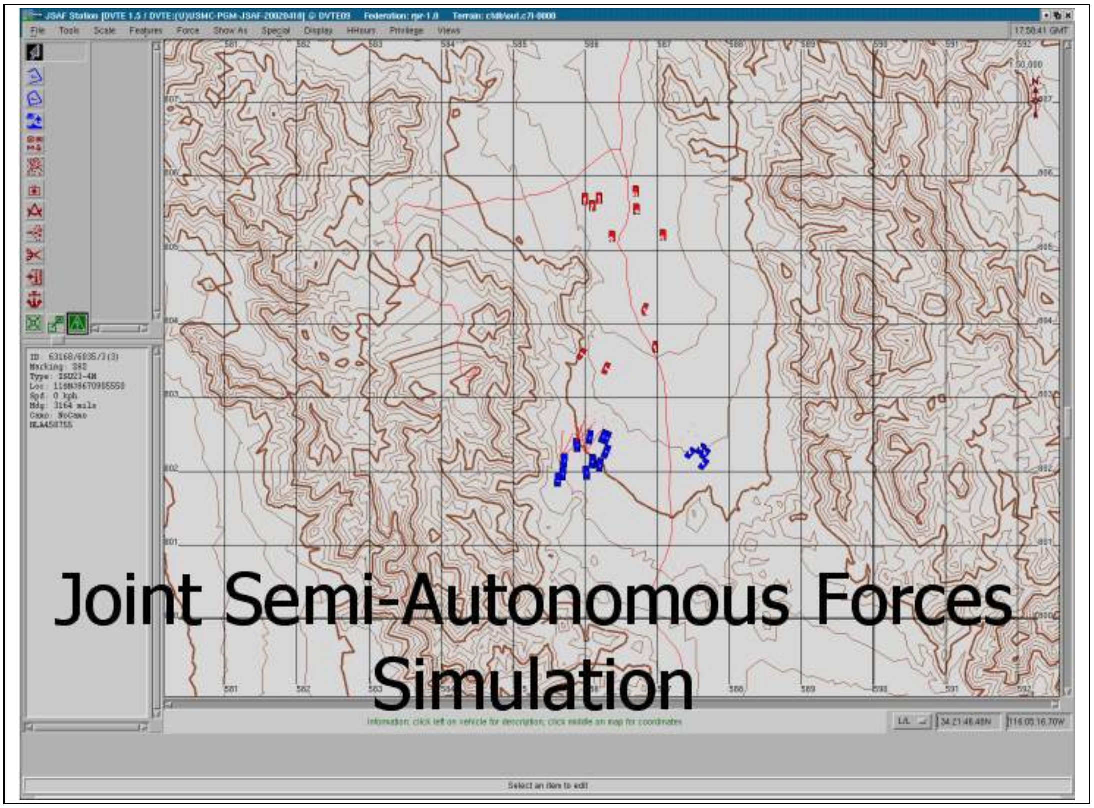
Why Use DVTE?



- DVTE enables sustainment of perishable warfighting skills when live training opportunities do not exist
- Key performance parameters of DVTE are specifically focused on vital individual, team, and unit skills

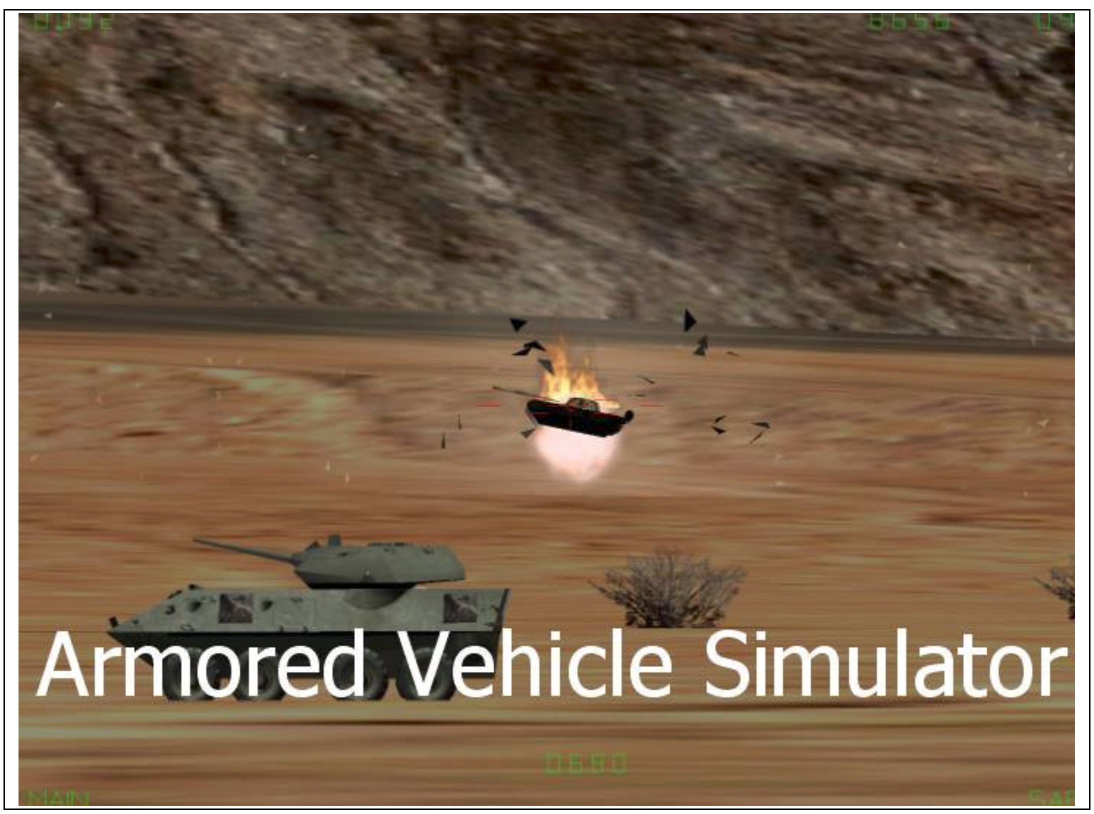

USMC
Training with the CAN
FW/RW
FIST
AVS
R&S
Marines Operating Platform Specific Simulators
SAF (Simulation)
AAR
COMMON SYNTHETIC NATURAL ENVIRONMENT


Common Tactical Picture
Via
Common Synthetic Natural Environment


Joint Semi-Autonomous Forces Simulation


Reconnaissance and Surveillance Simulator

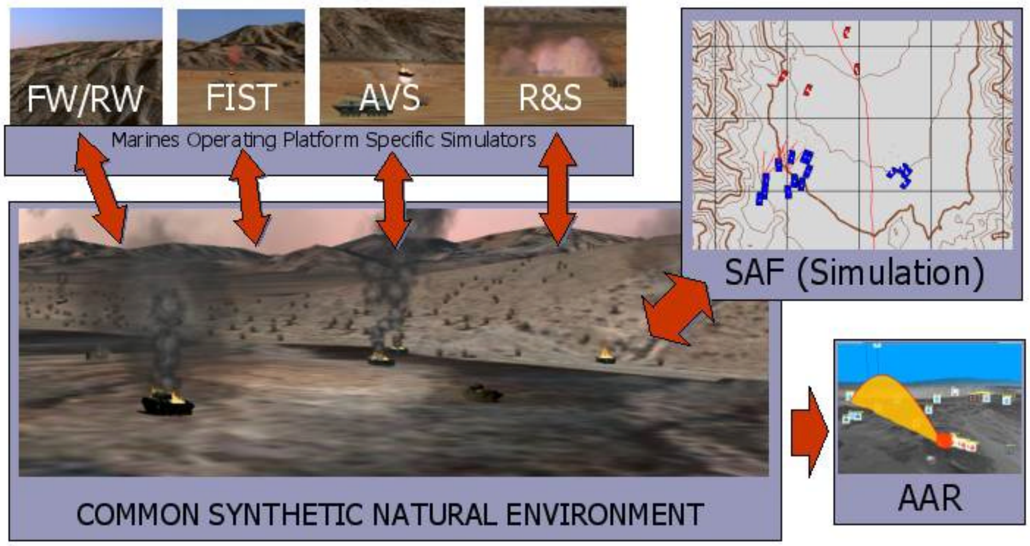

Fire Support Team Simulator


Armored Vehicle Simulator

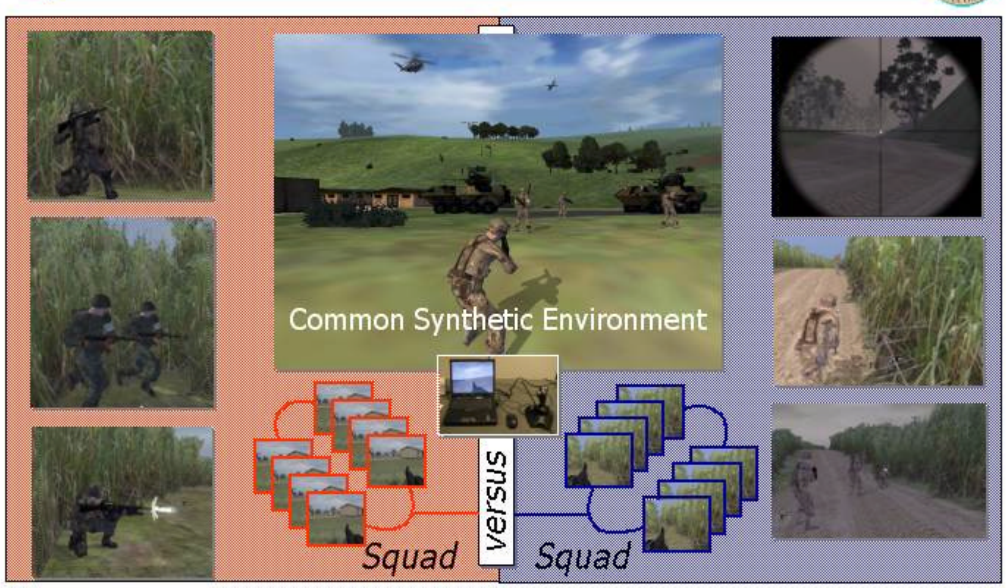

Aviation Simulator

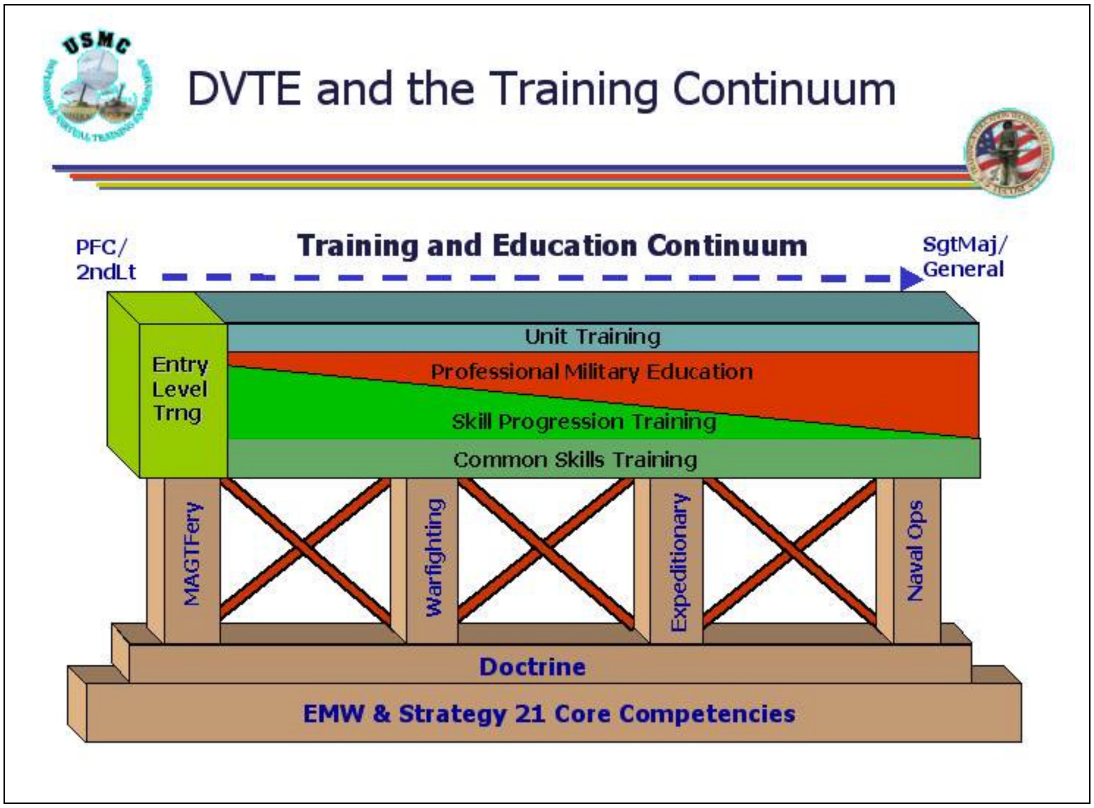

After Action Review
DD
black1
WOLF1
SCAR02
100A11

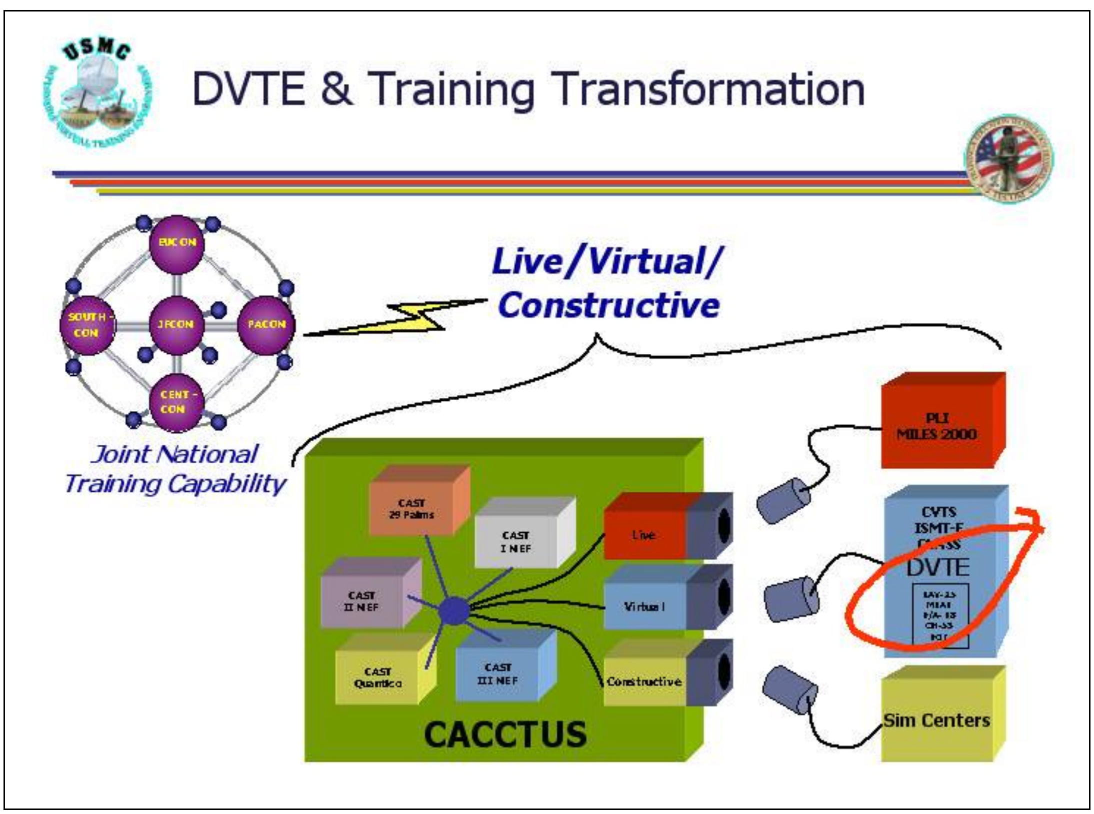
Training with the CAN



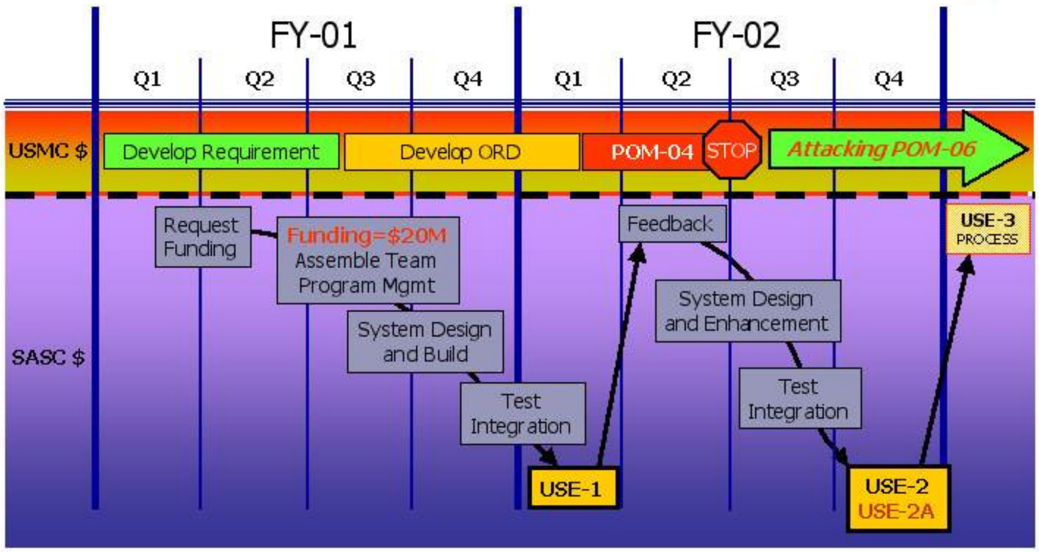
Training with the ITK




USMC
DVTE and the Training Continuum
Training and Education Continuum
PFC/
2ndLt
SgtMaj/
General
Entry
Level
Trng
Unit Training
Professional Military Education
Skill Progression Training
Common Skills Training
MAGTFery
Warfighting
Expeditionary
Naval Ops
Doctrine
EMW & Strategy 21 Core Competencies


USMC
DVTE & Training Transformation
EUCON
SOUTH-
CON
JFCON
PACON
CENT-
CON
Joint National
Training Capability
Live/Virtual/
Constructive
PLI
MILES 2000
CVTS
ISMT-E
DVTE
CAST
29 Palms
CAST
I MEF
CAST
II MEF
CAST
Quantico
CAST
III MEF
Live
Virtual
Constructive
CACCTUS
Sim Centers

DVTE History



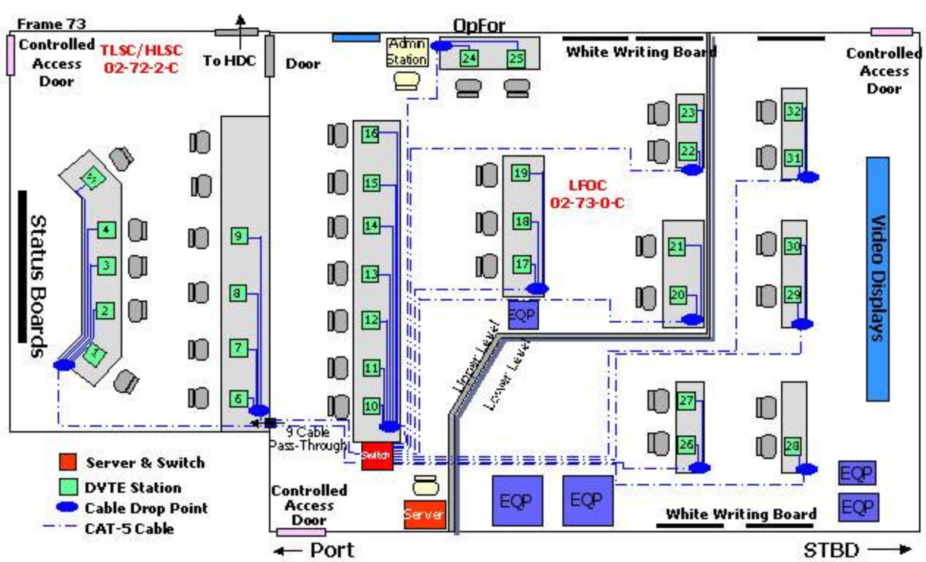
What was DVTE USE-2?

- User Scrutiny Event
  - Second opportunity for direct Marine feedback
  - Part of the Marine-In-The-Loop design process
  - Testing throughout development
- Evaluated, validated USE-1 improvements
  - December 2001, II MEF Sim Center
- Shipboard event allowed evaluation in primary operational environment

USE-2 Objectives

- Improve systems per requirements gathered during USE-1
- Achieve technical vision
- Extend to other warfare areas
- Focus assessment on military utility
  - Does DVTE improve shipboard tactical training for embarked Marines?

DVTE USE-2 LFOC Layout



USE - 2 Events

- 8 July: AM: Marines arrive
  PM: Marines receive instruction on use of DVTE
- 9 July: AM: LAR Company Screen Mobile Assault Course
  PM: Mechanized Company Force-on-Force
- 10 July: AM: Helo Assault Course
  PM: Tactical Recovery of Aircraft and Personnel
- 11 July: AM: Infantry Toolkit: Small Unit Training
  PM: Mobile Assault Course

DVTE USE-1 Feedback

Marine Corp Order	List of Tasks	SME	FMF
MCO 1510.80A	ITS System for the Artillery Officer Occupational Field 08		
Task 0802.1.01	Task: Direct operations of the forward observer team	100%	60%
Task 0802.1.09	Task: Locate a target by shift from a known point	100%	80%
Task 0802.1.10	Task: Conduct an adjust fire mission	100%	100%
Task 0802.1.12	Task: Conduct fire mission with laser rangefinder	0%	60%
Task 0802.1.14	Task: Conduct a suppression mission on a planned target	100%	100%
Task 0802.1.15	Task: Conduct immediate suppression	100%	100%
Task 0802.1.16	Task: Conduct a fire for effect mission	100%	100%
Task 0802.1.27	Task: Conduct a mission on a moving target	66%	100%
Task 0802.1.35	Task: Direct a Close Air Support (CAS) strike	66%	100%
Task 0802.1.36	Task: Conduct Suppression of Enemy Air Defense (SEAD) using artillery	66%	80%
MCO 1510.85A	ITS System for the Infantry Officer Occupational Field 03	100%	100%
Task: 0303.01.02 (core)	Task: Direct LAV unit fires	100%	100%
Task: 0303.02.06 (core)	Task: Leads an LAV unit in a screening operation	100%	100%
Task: 0303.04.01 (core)	Task: Employs LAV-M in support of offensive operations	100%	100%
Task: 0303.05.01 (core)	Task: Employ LAV-AT in support of offensive operations	100%	100%
Task: 0302.01.05 (core)	Task: Make a tactical decision	100%	100%
Task: 0302.01.06 (core)	Task: Lead unit in operations within Stated Rules of Engagement (ROE)	100%	100%
Task: 0302.01.09 (core)	Task: Call for fires	100%	80%
Task: 0302.01.12 (core)	Task: Plan fire support	66%	80%
Task: 0302.01.13 (core)	Task: Lead a Fire Support Team (FST)	100%	60%
Task: 0302.01.14 (core)	Task: Direct the MEDEVAC of a casualty	100%	80%
MCO 3501.3C	MCCRES; Volume II, Infantry Units		
Task 02h.02.05	Task: Plan for employment of fire support	80%	100%
MCO 3501.15	MCCRES; Volume X Part B, Light Armored Reconnaissance Units		
	Section 10B - LAR Company		
Task 10B.1.6	Task: Report combat Information	100%	100%
Task 10B.1.7	Task: Pass combat Information and orders	100%	100%
Task 10B.1.8	Task: Employ command and control measures	100%	100%
Task 10B.3.5	Task: Perform screen operations	100%	100%
Task 10B 3.7	Task: Perform actions on contact	100%	100%
Task 10B 3.8	Task: Perform hasty attack	100%	100%
Task 10B 3.14	Task: Conduct tactical movement	100%	100%

DVTE designed to provide training to specific T&R task standards.

FMF participants and SME evaluators provided feedback which has resulted in significant DVTE USE-2 enhancements

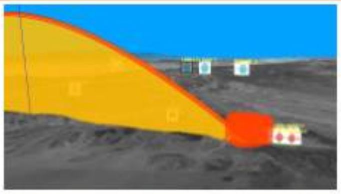
Future of DVTE

- Have funding through FY-02
- Currently, no FY-03+ funding
- USE-2A
- USE-3
  - Naval integration
  - Mission planning & rehearsal
  - Distributed at-sea rehearsal

What will make DVTE "ready" for Marines?

- Improve ease of use
- Additional system enhancements
- C2PC, AFATDS, ADOCS, ATWCS, BFTT, VAST, TBMCS, etc interface
- Rapid synthetic environment generation
- Additional user scrutiny
  - Shipboard, while deployed

Deployable Virtual Training Environment



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Section B: Homeland Security

The textual portions of some of the papers in this section are based on audio recordings that have been transcribed and edited by members of the Conference Organizing Committee. These papers typically consist of two sections: the textual transcription of the audio recording; and, a set of PowerPoint slides.

Homeland Security: A View Through the Eyes of Janus

Steven I. Cooper
Special Assistant to the President
Senior Director for Information Integration and CIO
Office of Homeland Security

Lee Holcomb
Director of Infostructure
Office of Homeland Security

It is a pleasure to be here this morning and to share some information with you. What I would like to do is the following. I'd like to give you a very quick overview of where we (Office of Homeland Security) have been, and then share with you where we are headed. Within that context, I want to take about the first 15 minutes, so somebody keep me honest and on time please… then I want to hand it off to Lee Holcomb.

Lee came on board as our director of infostructure, "I-N-F-O-structure". I will smilingly tell you that I spent over two weeks battling with the White House Office of Administration and Presidential Personnel over the fact that I was misspelling "infrastructure". So, if we put this in the context of transformation, which is the theme of this conference, it starts on a pretty mundane scale, but it is honestly representative of part of the major task of transformation that we are really about.

When I came on board in March, I was given basically three objectives by Governor Ridge and President Bush. The first was to help map out the national strategy for homeland security. We released that to the President in July, the President then signed that and released it to the public in mid July and I don't know if all of you have had the chance to read it. If not, you can download it from the White House web-site. Take a look at it. There's a lot in it. And so we were able to put a little checkmark by that task. I am using "we"… it was myself and Jim Flycik. Jim is special advisor to Governor Ridge and my deputy. Jim, many of you may know, was an associate secretary in the Treasury Department and the Chief Information Officer (CIO) of Treasury when we pulled him over. Jim and I basically drafted the chapter around information sharing and systems.

The second objective that we were given is deceptively simple when you hear it in words. It focuses on the essential information needed for homeland security. We can effectively translate that into combating terrorism, but with regard to the essential information for homeland security, and integrate the federal government. I playfully asked Governor Ridge: Well, that will keep me busy for a few months, what do you want me to do after that?

Prepared, as he always is, he then handed me the third objective. This objective deals with the essential information necessary for combating terrorism and homeland security, and integrating the federal government with state, local and tribal governments in the private sector. That objective is taking a little longer. Quite honestly, those really are my objectives, and we needed to reach these objectives yesterday.

The paradigm that we then began to shift into was to first shape some type of vision of where we needed to be. And this again was meant to be a national strategy, and therefore it had to be, I felt, a national vision. So, here's basically the very central national vision around information, integration, information sharing, information delivery, and information technology, because all of those are components of this vision. OK, expressed very simply and I am sure that you've already heard this in some form or another, but I'll show you where there are two fundamental differences: ***we basically have to ensure that the right information gets to the right people all the time***. I am sure you've heard these phrases many times: right information; right people; and, right time. So, the first paradigm change is: ***all the time***. In the war that we are fighting, and it is a real war, it is all the time. That in itself is a huge difference in how we think about information delivery.

The second difference is more subtle, and that's about ***the right people***. What I found when I came on board is that there appears to be no federal agency whose mission includes collaboration with another federal agency. I don't mean this in any negative sense, so please don't hear my remarks as critical. There are good reasons why things were the way they were, and are the way they are. I don't think it's because anybody gets up in the morning and decides: Let me see, what can I do to mess things up today? Nobody starts their day that way, and nobody's mission is about messing up. It's about helping and accomplishing the unit's mission. But it is interesting that I could not find a federal agency whose mission includes collaboration with another federal agency. It's just an observation. It's not right or wrong, it's just an observation.

OK, so let's come back to ***the right people*** for a moment. The paradigm that I found and that I am still finding to a large extent is based on "need to know". One can argue that there are a lot of good reasons for this. The intelligence community has beaten me about the head and shoulders as to why everything we have to do is based on need to know. OK, fine, I accept this. There are certain things that I admit I am not necessarily going to take on as major transformation. I am not going to take on the intelligence community on the issue of "need to know". The Department of Defense (DoD) tends to lean in the same direction, to a somewhat lesser extent. Interestingly enough it's not so much pure need to know in the intelligence sense, but rather… forgive me for saying this, again I don't really mean it critically… but it's entrenched around the respective services. Certainly, the Marine Corps, Navy, Army, and Air Force, have done really good things within each of their services. However, interestingly enough, when you get to the DoD level you find the same type of mindset: We accept that this guy is in the Navy, and we are in the Air Force, but wait a minute, why does this person need to know… blah, blah, blah, and so on.

So, the notion of ***the right people***, as we have defined it at this point in time, gets in the way of what we have been tasked to do. Lee, myself, Jim Flycik, Bob Shepherd, and Mike Resnick who is on detail to us from the FBI, are the core people. A pretty small team. I think it's a very, very high quality team and I've been very, very impressed by the quality of people that I've talked to and met in the federal environment. But, we need to kind of turn ***the right people*** paradigm… and I won't say around… but we need to shift it slightly. It is my contention that we really need to move toward… and I know that this is part of the theme that all of you have been talking about for some time… we need to think in terms of an information-centric type of environment. So in fact, if I have a role to play in whatever my job mission and organizational unit is, I need information to do whatever I do. Now, let's play on that for just a second. Whatever I'm doing fits into some type of process. I am going to call it a business process, because quite frankly we

are talking about the business of homeland security. There are major business processes for homeland security. Let me tell you what they are. Prevention, detection, protection, alerts, and warnings, and… God forbid there should be an incident… incident management. Some of you might call that disaster management or consequence management. We are calling it incident management, response, and recovery. Those are the major business processes of homeland security. Now there are some cross-cutting processes. Legal, policy type of activity, information technology… it's cross cutting and not really a business process. However, information delivery is a business process, research and development, and communication in the people to people sense, not telecommunications in the technical sense. Then there a couple of other supporting types of things, but those are the business processes. If I need information to do my business process, and if I have a role to play, shouldn't I be able to access whatever information is needed in the end to end process that I have a role to play in? That's a question, and I'm posing this question today. I could put a couple of you on the spot and ask you what do you think… and maybe we'll do that.

My argument is that this is the beginning of a thought transformation that I think can lead to a more effective way to accomplish the objectives that we have been given. Let me give you a very real life example. The business process that begins with a foreign national applying for a visa outside the United States and ends when that individual travels to the United States and leaves the United States. Take a guess how many federal agencies are involved in that process today. There are 11 federal agencies involved. Now guess what? Each one of those agencies has a piece of that process. And guess what else, they don't see anybody else's piece of the process. Think now… that's not because anybody consciously set out to design that process in that manner. It's because the powers that be in the federal government, over time, chose to assign various pieces of that process to various agencies. And each of those agencies set about to do the best they could do in their domain of the process. But over time, you end up with 11 agencies and 11 stealth plans that aren't integrated.

The transformation and the approach that we're taking to kind of begin to change this paradigm is to develop, construct, and populate a national enterprise architecture for homeland security. Very simply, if you're not familiar with the concept of an enterprise architecture, let me define it for you. If you were to draw a triangle on your notepad in front of you and at the very top of the triangle draw a horizontal line, and within a tiny triangle inside there just write "national strategy". Then that's the business strategy for homeland security. We have released version 1.0 of the national strategy for homeland security. Those of you who have anything to do with information technology know that you don't want to necessarily buy version 1.0 of any software. I don't think we're quite that bad. I don't think we have quite as many bugs, but I won't kid you. The strategy that we have released is a first strategy. We need feedback. We need dialogue from all sectors, public and private. We need feedback from individual citizens. We need feedback from our allies outside the United States. So part of the purpose in the first release was to engage that dialogue. And we've begun that process.

Strategy, as you know, is dynamic. I served in the Navy on active duty for a couple of years during the Vietnam era, and subsequently spent 14 years flying naval air in the reserves. When I was setting up my own company during that period of time and talking about my strategy and this and that, my commanding officer looked at me and said: "Steve, strategy is what you use when you run out of bullets." Well, I didn't argue with him at the time and I'm not sure that I agree with him, but be that as it may, the top layer is the national strategy. The next layer down

is really where you'll find the capabilities, the strategic capabilities, the functions, and the major business processes of homeland securities, and those are the ones that I described to you. The next layer below that represents the information. We need to successfully carry out those major functions, deliver the capabilities, and successfully execute the processes in that business process layer. OK, so those top three layers are about the business and they really don't have anything to do with technology.

Now, there are also three bottom layers… so you can kind of draw another couple of lines. In order, the next layer down can be thought of as the equivalent of applications and/or decision support capabilities that automate and enable the three layers above. The next layer down deals basically with what I'm going to call desktop services, pervasive services in an automated way. So for example, if you're a knowledge worker or if you're a warfighter, those computer-based, electronic devices will deliver a lot of pervasive services. That's for example where you find e-mail, or file and print services. The bottom layer is basically the stuff that you never see, it's behind the screen, it's where you find most of your local area networks, your wide area networks, virtual private networks, and that type of thing. So it's all the technical structure that supports everything else. Quite simply, we need to develop and populate a national enterprise architecture for homeland security. This is one of the major deliverables that we are working toward.

We have engaged state governments through a working group of state CIOs (Chief Information Officers). This is one of the areas where Lee (Holcomb) is leading the charge, so to speak. There is a poster board that we set up outside. You might have seen it when you walked in. It's very much a work in progress, and has not yet been vetted by the agencies and others. We have set up some CIO working groups in the federal environment. These are comprised of CIOs of the agencies that will become part of the new Department of Homeland Security. We are tackling the major processes and information around four groups that are represented in the President's proposal for the new department. The poster board shows you a glimpse of the "as is" state of what we found. It also shows a conceptual diagram of the concepts "of push back the border" and "smart borders" that are beginning to evolve. In fact, Rob Quartel, I think is speaking to you later this afternoon and will probably expand upon the "smart border" concept.

The second area that we are addressing deals with emergency preparedness and response. You can think of these as directorates or divisions inside the new department. The third is new capability, such as information analysis and infrastructure protection. This is a new capability that the President and Governor Ridge want on day one, and I will try to give you a little bit of insight into that area later. And then, the fourth area is science and technology. The role that broad technology (not just information technology) plays is critical to bringing a lot of the technology that exists in America on-line, quickly and effectively.

So that's the national enterprise architecture and that, as I said, is one of the major things that we are doing. Let me tell you some of the other things that we found. One of the major tasks that we have embarked upon is to basically create a virtual consolidation, or a virtual single watch-out list. This is a word that I invented after I went to talk to the intelligence community and they told me about their "watch list" of bad guys that we don't want in the United States. Also some civilian agencies, the State Department, and a couple of others call them "watch lists." When I went over to DoD, and those of you who are now or were formerly in the service know this, I found out that a watch list is not about bad guys that we want to keep out of the United States. It's a list I don't want to be on because I don't want to stand on watch, or do that duty, or

something like that. So DoD refers to them as "look-out lists." The airline industry has another acronym that they use. So, playfully in one meeting with a couple of representatives I suggested that we just call them watch-out lists, and this name appears to have been accepted for the time being.

But here is what we found. There are 14 major watch-out lists. This is not because anybody is doing the wrong thing. Rather, it's again similar to what I described to you previously. Each agency has a mission, and they created for their purpose and their mission a list of people that they want to keep out of the United States. But we need to make certain that the names that are on any of these lists are on every list. So we have embarked upon, literally for the first time in history, a process of pulling all these groups together and figuring out how to create the equivalent of one list. Technically, we can achieve this. There are different approaches that we can investigate, that we are investigating, and that we are looking at. But the challenge is around people and process, not technology. Like it or not, this is "turf". People protect turf when it's time for change. We will work through it. It's too critically important not to work through it. So, the motivation to work together is real. If we don't catch somebody that we need to catch, people may die. It's that simple, and that's a very powerful motivator for change.

In fact, we found that we had only started to peel back the onion a bit. Underlying these 14 major lists, there are 58 minor lists. Some of the 58 are fed by databases and other lists. Some of these feed the major lists, and some don't. So this is real. Numbers are real. This is what we're finding. This is what we've got to tackle, and we have to do it yesterday. We need help. I mean those of you who represent the private sector, we believe that an awful lot of the solution sets that we're looking for around information technology are in the private sector. Those of you who are federal agencies, we need your help. My challenge to you is as follows. You need to think more broadly. I know I'm lecturing… you're right, I am. I'm asking for help. I'm suggesting that you need to think more broadly if you're mission is related to homeland security. Certainly those of you who are in uniform might think… I don't know whether I should believe this guy or not. I am simply planting a seed. You can nurture it and help it grow, or you can decide… I listened to the guy I don't agree with him, and that's perfectly acceptable. That's what we're about.

That was one very real example, and there are others. We are also addressing the need for "vertical integration" around state and local governments, and in the private sector. We are putting together some forums in major cities to actually talk with and listen to state, local, and private sector representatives. Our first forum to engage the first responder community is coming up in Atlanta on October 16 and 17. Georgia Tech and its Institute of Homeland Security is jointly sponsoring this forum, and you'll hear from Tom Bevan this afternoon. Tom, his institute and Georgia Tech have provided an enormous amount of help in putting this together. The other cities that we are initially targeting include Indianapolis, San Diego, and Seattle. We are trying to cover geography, but we're small staffed and therefore we can't move as quickly as we would like to. Part of what we're doing here is to look for best practice. I believe very strongly that an awful lot of the solutions that we need already exist. We just have to locate them, identify them, and raise their visibility. One such example that we found is the emergency response network that has been built by the local community in Dallas. They've actually pulled together with the local FBI, law enforcement, public safety, public health, the hotel and hospitality industry, the private sector, and they've done a marvelous job of creating a web-enabled emergency response communication network that they use every day. This resulted in the arrests of various people.

It's an example of best practice that we believe in, and we would like to kind of replicate it and make it known across the United States. And so those are some quick examples.

Let me stop and turn this over to Lee Holcomb, to talk a little bit about some of the observations that he has, and then let us give you a chance to ask some questions and we'll try to respond as effectively as we can.

Thank you. First of all we haven't coordinated this talk at all, so it will be interesting to see if it fits together or not. Many of the things that I'm going to touch on will cut very coarsely into things that Steve had mentioned. First of all I have to say that it has been a great honor and challenge to come in and take on the activity of trying to put together a sound architecture… an enterprise architecture for homeland security. The pyramid framework that Steve described is in fact the framework that was developed by the federal CIO counsel and promulgated over the last two or three years as part of the guidance to the various federal agencies for putting together an enterprise architecture for their respective agencies. We're trying to follow that guidance as we move forward and develop an enterprise architecture for homeland security. It starts at the top with the strategy that was mentioned, and then gets down into the business process level. The chart that is outside is in fact an early product of one of our four working groups involved in the review process right now. We would welcome any comments you would like to provide.

It addresses one of the four areas that Steve mentioned… the area of border and transportation security. One of the things that I believe is important is to look at the information sharing processes that support these business processes. They do differ depending on who you are and where you are in the cycle. They may include a technology of pushing information to individuals, and they may include a process of pulling information or a process of subscribing to get that information. It may be a process where you simply want to generate a query. If you're a border guard you may just want to know if is this a bad guy and what do I do about it. Or, it may be a process that requires access in order to engage in peer-to-peer collaboration. All of those processes are ones that we need to understand… which ones fit the individuals and their interests and how do we actually architect the system in a way that we can make it happen? The notion of "need to know" is going to end up, as Steve mentioned, as an inhibitor to the ability of these processes to work. I think it's highly doable but we certainly would like your thoughts and ideas on which of these particular ways of sharing information are appropriate for the different processes… and ideas on how to make it happen.

Another key part of the strategy document that the President has put out is the whole area of creating metadata… ontologies if you will, for various communities. I think, if you look back historically over the past eight to ten years, there are communities that have addressed this on-line issue. I will mention two of these organizations, because I believe that they have done a pretty good job. One of them is the National Library of Medicine. They have the advantage that they teach medicine and the terminology that they use is kind of somewhat under their control. The other is the Eisenhower Library for Education and their digital on-line library that the NSF (National Science Foundation) and the Department of Education have funded. Both of those organizations have done a pretty good job of developing ontologies and metadata. But when you get beyond those communities, and certainly when you get into a lot of the tactical military areas, it has been more difficult to see that development. We need to find ways to motivate individuals to help develop those standards… those metadata standards. Also, we need to reward people for success in this area, and make it easier to contribute.

Many of you have come up with ideas, such as… we just need to copy what various commercial entities are doing… we should build a huge data warehouse and we'll mine everything. I think that one of the conclusions we've reached is that it is highly unlikely that there will ever be one large warehouse of data. Due to privacy concerns and many other factors we need to find a way to work with systems… sets of systems and not one large mega system.

There is another observation that I would like to share with you on looking back over the last 10 to 15 years. Right after Desert Storm, you may or may not recall, there was a pretty large outcry that the intelligence community failed in supporting the tactical warfighter. They did a great job in getting information to the beltway here. A lot of excellent networks around the Washington area got that information here for strategic national decision making, but the poor guy there on the warfront wasn't getting that information. There were hearings and discussions about it at that time… and over the last 10 years DoD and the intelligence community have worked very hard to try to break down those barriers… to try to get that information out to the warfighter. I think today we see significant improvement in that linkage, and there is a lot of expertise to draw from the military in that regard.

Anybody watch the news last night? Notice that they had hearings yesterday on the failure in the intelligence community to get information out to those who needed to act last year on September 11. It's the same problem, but we are dealing here with a much broader community. It is easier to push information out to a warfighter who may have more of a trusted relationship. In respect to September 11 we are talking about pushing information out to a much broader community. One of the biggest challenges we have is to deal with how we can disseminate this information to individuals that may not have the same trusted relationship that the warfighter has. I believe that there are many lessons that we can take from the military and how they tackled that problem in the 1990s. Last week in a workshop with General Kellogg, we addressed some of those issues and I think that there's a partnership that we can form with that community. Everyone has said this before. I've watched it in my own organization.

This week there's a new Harvard University business case study coming out that I happen to be a participant in. It deals with knowledge management within NASA… what went right and what went wrong and like all Harvard business cases, it doesn't all look rosy. I can tell you right now that NASA is a highly technical agency that has ready access to the technology that's out there. Knowledge management wasn't working well in the agency, not because of technology issues but due to it's culture and it's incentives. Much of what we had spent time on in this case addresses the question of how do you provide an environment of incentives for people? How do you create the culture and the rewards to promote knowledge sharing?

Information sources are very important. As you know, traditionally we've been talking about information that flows among the law enforcement, military, and intelligence communities, at the core. There are additional extremely important information resources out there that we need to tap. The private sector. I worked a lot with the aviation industry in NASA, working on the safety of aviation. The airlines have huge amounts of information on their flights can be mined for safety and security purposes. Yet there are disincentives to those companies to share that information. They don't want their competitors to get it, so we need to find incentives and ways to collaborate with industry to protect the things that are competitive, but be able to extract from that the information what we need for security purposes.

The other community that's really important is our citizens. We need to find ways to get information from citizens that can help us. We need to do it in a way that doesn't infringe on privacy concerns, and we need to deal with a wide variety of legal issues associated with citizens providing information. We need to be able to vet this information in some way, and we need to be able to categorize it in terms of quality. But we need to find a way to bring the information from this wide set of sources together. We need new models for doing that. We welcome your thoughts on how to do that.

The last comment that I will make is related to something that Steve and I were talking about yesterday. When you look at these mission control centers or incident centers, what you see is a room full of screens, with a little sign on top of each one… for example, coming from NASA. If you look at the mission control center in Houston you see the same thing. You see a subsystem for propulsion, and so on, and so forth. Behind all of these are a lot of databases and, of course, different agencies and so forth. However, in the end it comes down to a bunch of people sitting there, in other words it's people to people connections. We need to find ways to deal with this paradigm and be able to not only assimilate information within a community, but to cross over and to deal with both the explicit information you can capture about a system and the implicit information that individuals have. How do we bring that together, and how do we find paradigms that will blend the automated systems that we have with the stovepipe systems that we have and cross over and endure effective communication between individuals.

Those are some of the challenges that I think we need to tackle. We would welcome your thoughts and ideas, all in the context of homeland security. So with that I think I'm going to stop and open it up. Steve, if you would like to take and field some questions.

<u>Questions from the audience:</u>

Question: *So you're asking for our ideas, but you say there is no funding. Where do you want us to send all these ideas? How are you going to process them? You challenge the group, where do you want us to turn.*

Cooper: OK, here's what we're doing and admittedly you're hitting a couple of the challenges we've got. Technology, particularly broader technology, scanning devices, sensors, and things like that we're actually channeling through the White House Office of Science and Technology Policy. There's a group that supports them… the TSWG working group. I think that's a process that apparently has been in place for a while. It certainly existed before I got here. It's a process that is kind of geared up to work on a much larger volume faster than our small office obviously can, meaning the White House Office of Homeland Security. However, that group is not well equipped to deal with information technology. It's really not their focus. Therefore, what we've done internal to the White House Office of Homeland Security is to link up with the Department of Commerce. This may not be the best solution of the moment, but they are equipped and can help us and are helping us with a first pass at handling the volume of proposals and information that we're getting.

Question: *Have they gone out with a BAA yet?*

Cooper: No, we've not gone out with any BAAs yet.

Question: *You're just ad-hoc-ing?*

Cooper: Well, yes, if you want to think of it that way. We have a process. I'm not sure it's quite ad hoc. I think it's a little more structured than that. But we have not formally gone out for requests for proposals or some type of procurement action specifically related to homeland security. Why? The White House Office of Homeland Security is not a procuring agency. We're an advisory agency, and we are not replacing the existing procurement channels within any of the agencies that are proposed to become part of the new Department of Homeland Security. So one mechanism is to continue to talk with those agencies.

Question: *Who will those agencies be in the administrative system? Do you anticipate that it will be the Department of Commerce?*

Cooper: In the long run it will be the Department of Homeland Security. Once the legislation is enacted, it will become the Department of Homeland Security. And the Department of Homeland Security will then: (1) take on procurement authority; and, (2) become the lead agency for anything related to homeland security. We're not there yet. Unfortunately we're in this kind of transition mode.

Holcomb: I would just like to add a comment, Steve. We have created these four cross-cutting teams that are looking at the different business processes. They are not initially intended to fund activities. However, as a group, for example in the border and transportation security area, we would look to that working group to vet a proposal in their area. So we will begin taking these pilot activities before those groups to establish goodness of fit to the business processes that we're in the process of developing.

Question: *How do we get good ideas to you?*

Cooper: The easiest way, although you have to bear with us on timing a little bit because we're currently running about a four-week backlog is to send stuff directly to my staff… to me or to Lee. We will leave our cards on the table somewhere and you guys can pick them up… send it to us by e-mail. We are actually working through these e-mails. In the time that I've been on board, we've probably worked through over a thousand inputs and/or proposals, many unsolicited proposals. Not perfect, but it's better than nothing.

Question: *In what you've explained here, and you started off by indicating that moving into an information centric environment is important and an opportunity that we can't miss right now. It seems that there are five sort of concurrent processes that you're involved in… a kind of summary of what I heard you say. Firstly, you obviously need to know what is the status, what is available out there, and also what are we doing wrong at the moment. You and your group are bringing a great deal of expertise from industry… that's something that you had from day one. Then secondly, however, there is a transition that is taking place because we're not an information-centric environment right now. We're in a data-processing environment. So there is a need for leadership and vision to get things started… to move in the right direction. And there is a great deal of need for coordination. But there is also a need to show industry, government, users, and agencies what this information-centric environment can provide for them and how we can get there. And that's probably a real problematic issue for you. Because on the one hand, there is urgency and you want to start some major project, you want to create an architecture. On the other hand, the world is not really ready for that major architecture right*

now because we haven't gone through the transition. So then there is the possibility of some very fast pilot project to show everybody what this architecture could be. Could you address this a little bit? How are you going to proceed with this very difficult problem?

Cooper: Yes, absolutely. In fact, what we're doing is really operating along two parallel paths. What we have to do is exactly what you just described in the process of developing an enterprise architecture… about creating a vision… about creating leadership that moves us from wherever we are to an information-centric type of environment. We've begun that work. You've heard us talk about the CIO working groups. You've heard about what we're doing in this area. In parallel, we are also identifying pilot projects to demonstrate what might be successful… what does the desired end state look like. Here we were are temporarily delayed. I'll phrase it this way, we're temporarily delayed because the funding for pilot projects to speed up the enterprise architecture is in the President's 2003 budget which is in Congress… and that's about as much as I'm allowed to say about Congress. We do indeed have several pilot projects identified. I can share a few of them with you. There's the 10-state coalition led by the Florida Department of Law Enforcement that is going to link and share some knowledge management tools, analytical tools and capabilities, for law enforcement sensitive information. I mentioned the Dallas Emergency Response Network which we would like to replicate in other environments across the United States. Also, there's the virtual watch list consolidation that we've begun work on even though we don't have the money. So, there are several pilot projects we've identified.

Holcomb: We are also working the Joint Chiefs of Staff. They are seriously looking at some collaborative projects in appropriate areas. One of those is protecting critical military infrastructure. The President's strategy has laid out the various infrastructures that are in the US, and DoD has been assigned as the lead for all of the infrastructure that supports our bases and military operations. They are looking at a pilot project in that area as something they might get going. So, even where we don't have HLS direct funding, agencies that are coming into it will collaborate with us. We're planning to encourage a selective set of pilot projects.

Cooper: We've had some very constructive discussions with the Department of Defense, including Northern Command. In fact just yesterday I talked with General Kellogg (J6, Joint Chiefs of Staff) about this national enterprise architecture. We're also working very closely with General Meyerrose who is tasked with effectively guiding DoD's enterprise architecture for Northern Command… so we're linked, and quite simply DoD has money. There are absolutely ways to get things done. For example, in talking with General Kellogg and saying, look you take the lead, you've got the funding, let's link up, let's move forward. Maybe I have an advantage in that I don't know what I don't know… and until somebody comes along and says you can't do that, my approach is just do it. I admit to carrying over from the private sector, but so far it's worked pretty effectively and I haven't gotten fired, and I haven't gotten into trouble yet.

Question: *There are not a lot of people out there that know what all the other agencies are doing, how they are doing it and why they are doing it?.*

Cooper: Ok I'm going to give you a totally honest and candid answer. Yesterday morning, Lee and I were standing in my office and I said, Lee, we need to get a great big sheet of white paper, stick it on the wall and start putting yellow post-it notes for every project we've identified across all these agencies. Now, is that very sophisticated from a technology standpoint? No, but in reality what we recognized is that we are in a unique position. OK, we probably are at the beginning of knowing more about what's going on related to homeland security. We obviously

are far from knowing everything that's going on related to homeland security in every agency in the federal environment, state and local, and private sector. However, we simply need to take this collective knowledge that we have and publish it. First we need to get it out of our heads and off all these notes we've got scribbled all over the place… and honest to God that really is what we started doing. We actually can do that quickly, publish that information, so that people can cross-pollinate.

Question: *I agree, but to what degree is human interaction involved? Getting people in the same room just to dialog or speak on issues... firefighters vs. emergency response personnel vs. VIPs... very different kinds of people.*

Holcomb: It's a difficult issue. I spent 20 years involved in what was under the Regan administration called "Fix It", and then after that it got transformed into the National Science and Technology Counsel, and after that it's gone into Community on Information, and so on. I can't remember what it is called now… it's gone through three or four different names. A lot of what that committee did, at least on the R&D side of the federal government, was to try and get the agencies that are involved to talk. Exactly what you're saying is what we found. If you stay at the management level, you don't get the kind of interaction that you want. Quite frankly you get folks that are trying to advocate budgets and they're somewhat competitive. When you get down to the technical level, the people that are actually working the projects, you find that people are doing very similar things. When they start to talk to each other they're going to say, why should I duplicate. Why don't I work with you and collaborate. That's what we found in this program and, by the way that program led to what we know today as the Internet. OK, the 'Fix-It' initiative supported the original collaboration between DARPA, NSF, NASA and DoD that led to the development of the Internet. This happened mostly at the grass roots level because people wanted to work together. It turned out that this model worked really well because you got more out of it when they collaborated because you didn't have to connect so many different places by sharing. That group has experienced exactly what you're talking about. Do we have that for homeland security today? Not exactly, we don't have that infrastructure in place yet.

Question: *One more question Steve. As you struggle with this incredible task of the overall national coordination, you also have to deal with some very real vulnerabilities that exist right now. One of these vulnerabilities that has been discussed here… we had Larry Mallon and John Hwang talk about it yesterday and Rob Quartel is going to talk more about it this afternoon, is the goods shipment area. In this area we are very vulnerable at the present time… I think we all understand that. So as you struggle with the national infrastructure issues, how are you able to address the critical vulnerabilities… and there probably are more, but this is one is well known.*

Cooper: Yes, the group that's kind of leading the charge actively on that is a group that again is being supported by our office out of the White House. There is a container working group that is actively working on a policy at the coordinating level This group has made a number of recommendations to the appropriate agencies, including the Coast Guard, INS, Customs… those are the major ones. So again, there's parallel work going on. We recognize that we have to do stuff today at the same time that we're shaping tomorrow. And you know, is there some margin for error here? Yes, absolutely. But I think you have to bring a little bit of what I call pragmatic reality to the situation. At the same, I don't think that developing a desired state vision is mutually exclusive from doing things today. Some of the things you do today may not get you to your desired vision, but that doesn't mean that one should not do it. It's the right thing to do

under the circumstances right now. What we're trying to do as quickly as we can, is to shape the vision so that we can take any action that needs to be done and figure out whether it is basically in the right direction. I argue, so what if it's headed northeast, northwest, who cares? Make a midcourse adjustment, right? If it's headed south, then I think before you act upon it, you quickly evaluate, might there be an alternative, because south is going to be a throwaway. And then you have to make a business decision. Whatever the cost of that decision is… near term and longer term? You have to make a business decision… I'm sorry, I know I sound like a broken record, but this is about business and it's the business of homeland security.
Maybe last question, are we running out of time… last question…

Question: *Have you compared notes with the general public?.*

Cooper: We've begun that dialogue. It is not just the federal government and/or state and local governments feeding information to the average citizen. It's also what information the citizens have that they would like to kind of get into the government environment. We're doing a couple of things. First, we're looking for best practices that might already exist, where something is already being done to exchange information with the average citizen. That Emergency Response Network that I mentioned in Dallas is one example. If you go out to their web-site and I forgot the URL… if you send us an e-mail we'll send you the URL. They actually have a little web report that you can click on and fill out incident information on something that you as a citizen may have observed. It feeds directly to the local FBI office. When I first learned about this, I figured, well I'm going to give it a try. I filled out one of these report templates. It must have been about 8:30 at night or something and I sent it. I didn't make anything up, but simply entered, Steve Cooper, White House, Washington (DC). Honestly, within three minutes I received a call from Special Agent Art Fiero in the Dallas FBI office and the conversation was kind of funny. He introduced himself and I reintroduced myself, and he asked did you send a Shield Report… they call it a Shield Report… and I said yes, and I said I'd like to learn more about this. He said, well it's kind of late, can I get back to you tomorrow… I said of course. He called me back the next morning about 8:30 am. I answered the phone and he said this is Special Agent Art Fiero of the FBI. I said yes, I remember from last night, and he said: You really are with the White House. I said yes, and I said… it never occurred to me that I might cause a problem, I was just interested to find out how this web-site works. He came back and he said, well we've done a little research and how can we help you? This is funny… but it is an example of how we can begin this two-way dialogue.

The other thing that we're doing is related to the information-sharing forums that I mentioned previously. These provide opportunities to reach out and to listen to people who are outside the normal environments, and for the outside intelligence community to listen and understand, tell us what they would like to see.

Let me tell you about a vision that I have. Wouldn't it be kind of neat if any citizen in the United States could go to the Department of Homeland Security portal on the web and enter his or her zip code or street address… and what you get is anything relevant to your house or where you live that might be of interest to you related to homeland security. Wouldn't that be kind of neat? Now that's part of my vision. We've got the technology… if we can get past this people and process stuff, I would argue that we just added value for every citizen in the United States.

Homeland Security Through a Decentralised Matrix Management

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Matrix Management Concept . . .

A new administration is being formed for our Homeland Security. Unfortunately it is being created on a traditional "inline" management template from the top down to a working level. It is suggested to keep our present administrative government as many departments have built strong time-honored response capabilities. Our major problem is that the security issues within our government structures need to be identified, coordinated, managed and provided with resources to operate effectively. Here **Homeland Security can become the "crossline" "program managers".** They would act across the "inline" administrations at levels where security issues are handled according to that program. These two "lines" of management constitute a Matrix Management. Where they intersect we have "nodes" of direct control with delegated authority for responsible action and reporting up the "inlines". Now within each administration we can "sub-matrix" management or at least "parallel" manage to shorten the lines to the top.This way decision-making gets done quickly at a working level

> **. . . keep our inline government administration intact . .**
> **they now have working resources in place . . . and can expand . . .**
> **. . . Homeland Security develops viable security programs crossline . . .**
> **. . . with collaborating nodes . . . for immediate decision-making . . .**
> **. . . action . . . and reporting . . . that is Matrix Management**

A **decentralised** homeland security is well understood as the essential way to recognise and handle local breaches in security. Those many people in the field are more familiar with the situation, know the people, the resources to gather and what they can collectively rely on to get things done. With initiative they improvise by selecting information that is more meaningful in the context they know. Here we "let the trees of the forest grow" by allowing the various government agencies to continue to conventionally "inline" manage their affairs with top down administrative authority. We are now asking those inline managers to identify the security issues within their organisation, delegate responsibility from the top to a reliable technically competent manager to become the collaborative matrix "node" in the "crossline" homeland security programs.

A **centralised** homeland security is seen as the essential place to go for all national and international security issues, a resource for all information and a readiness to combat breaches beyond the local borders of jurisdiction. These become "programs" where select people see a broader scene within a context of cascading situations and global resources. Here we "let the forest with the trees grow" by inviting those centers of expertise and resources within government agencies to collaborate at all levels in the national programs. It is important to

"crossline" manage the programs in "nodes" at the levels where they can be effective in decision-making. Those nodal supervisors would be granted authority to respond laterally to the national program without having to go up the line for every decision. However those nodes would still be responsible for reporting actions and in accounting for the time and money in a shared program budget with the central homeland security resources who "program manage" those contracts. This way the Homeland Security becomes an administration of program or project managers with many resources decentralised in an effective collaborative administrative matrix and communications network.

Management : Management is ***people organising*** people and things to provide an environment for an effective performance in task, work and process. Managers get things done. It is the basic hands on, human factor in getting the appropriate people and things together for doing the job. Thus the leadership of this team must first define what has to be done and with what resources in order to build the organisation to do it.

Administration : Administration is the structure of the organisation for it to work, incorporation, the legal entity through legislation, a charter or articles of association. It ***empowers*** through a delegation of ***authority*** and codes of conduct for the organisation to be managed. Thus this leadership must first define the context of the organisation so that it can be authorised to be managed within the community in which it operates.

Security : Security is a building of confidence in those things that reliably guard us and our world against danger, attack, threat, loss of income, false arrest, stolen identity, seisure of property, fear, terror and war. Issues involve the signs of ***threat*** against our security, then the action of the ***breach*** in security, our ***reaction*** to mitigate the threats and breaches, the ***recovery*** from that breach, then the ***countermeasures*** for the threat, breach, reaction and recovery. It is important to categorise security according to the types of threats and breaches, rather than the trauma, terror, panic of the consequences. Talking about "counter terrorism" gets us nowhere ; address the causes rather than the effects ; thus solutions are to "counter threat" and to "counter the breach", in specific ways, that is Contingency and Emergency Planning. The initial signs may give no indication as to the degree the cascading events may lead to, so it is very dangerous to label it by extreme consequences. It is well known if you keep responding to false alarms nobody will believe you for the real one, so paranoia sets in. Cry wolf too often, the real wolf will get you.

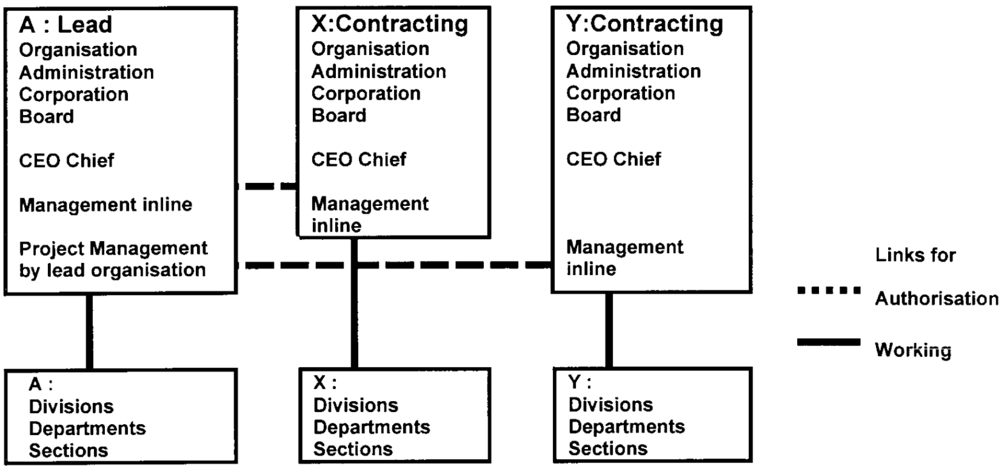
Contingency Planning : A contingency is the dependence on the ***chance of a sporadic event*** happening. Planning ahead both ***defines then anticipates or predicts*** the occurrence of those events ***before-the-fact***. Assuming we can define the parameters for that chance, then there are ***contingent trends*** leading to it happening. With a chance of happening… it will happen ; that is Murphy's Law. You do not know when, where or to what extent but the chance is there. Thus we use trend analysis in contingency planning. For security issues we focus on the "what if" outcomes of ***chance threats***. Countermeasures are to eliminate the chance of the what ifs. We use ***heuristic methods with sporadic models*** to discover those events, then ***trend analysis*** to find the combinations of contingent subevents. We often use contingency planning in facility management by staging outages for repairs, periodically testing alarms, calibrating control systems, and using AIMS Automated Integrated Monitoring - Management Systems.

Emergency Planning : An emergency is the dependence on the ***probability* of an adverse event** happening. That is the chance now becomes a probability in the ***odds it will happen***. It is ***after-the-fact*** of the occurrence. Here we know the cause and effect so we assign a probability for the risk in the consequences of those events happening. Like insurance it patches up after the breach in security. Thus we use ***after-the-fact investigative, reconstructive, probability models in analysing*** emergency planning. For security issues we focus on minimising the breaches and mitigating losses. So those contingencies become emergencies when the chance of cascading threats become ***probable breaches*** that we recognise and can respond to.

Inline Management : Top-Down, Hierarchical Administration : Bossland : Inline management with its top-down administration is a sequential tree-like delegation of responsibility within an organisation. Each succeeding level of authority depends on the effective decision-making of both the one above and below it. This is fine for a sequential order of dependent decisions, like in legal court procedures or filing applications, where each cumulates then culminates in a final decision by a judge or assessor. Inline organisations depend on the top person thus when they change or die it severely disrupts the whole line. This hierarchical organisation is from the concept of a "sacred ruling" or feudal with respect to property control. It is very time consuming, pedantic, with managers signing off at each level, but worse is that ***decisions can not be changed*** along the way. Changes reflect failure and it is difficult for those inline managers to save face so they pass the buck without modifying the situation. Inline management is ***hopeless for contingency planning and emergency responses*** to breaches in security where decisions are changing by the moment and action has to take place immediately without top-down authority. The point is that emergencies reflect poorly on the organisation and the lethargic internal reporting with public disclosure frequently fails to satisfy those outside parties or organisations who are affected.

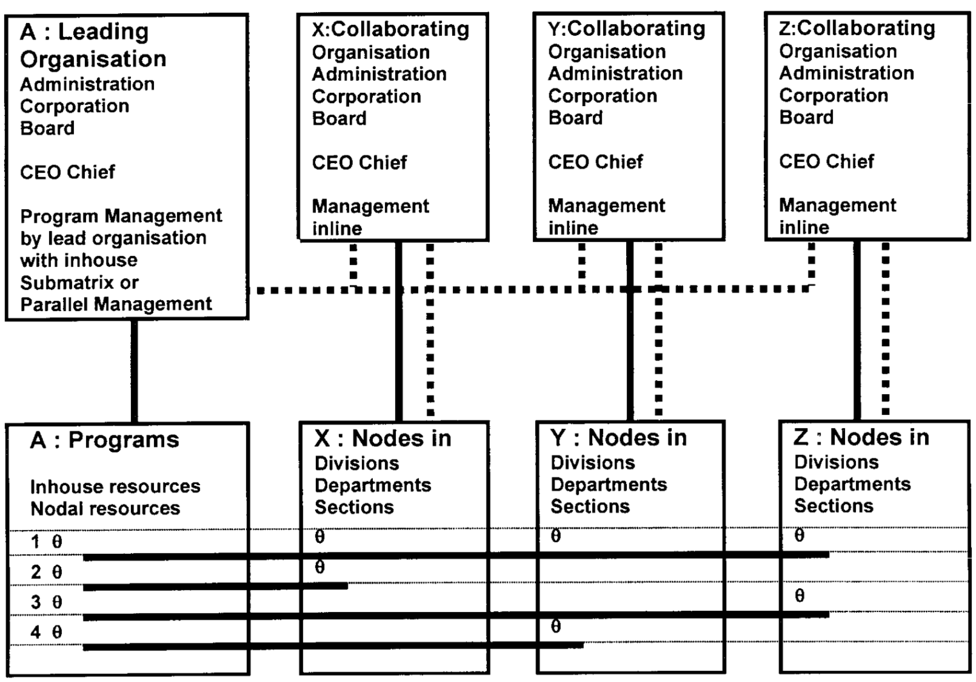
Parallel Management : Round-Table Administration : Camelot : Parallel management with its round-table administration has representative managers, ***each having parity*** or "equality" in the decision-making process, all presided over by a nominated Chair. I liken it to the Arthur's Knights of the Round Table with the King presiding. Each representative manager has their ***own portfolio of responsibility*** to account for. Significantly, important ***issues can move more rapidly*** to the top management without being delayed or blocked by inline managers.In parallel management the individual representation and nominated Chair can be easily changed with little disruption to the organisation. The major question is in how you ***weigh the inequitable decisions*** around the table. A recognised parliamentary procedure for meetings usually decides by a vote with the Chair casting a deciding vote or a veto. Frequently the aggressive "dominant monkey" wins as the saying goes in behavioral circles. Unfortunately in boardroom tactics portfolios are often distributed according to the political camp of those above, who makes the money, who budgets to get things done, then the allegiances in sway votes. To alleviate these problems there should be many ***informal meetings for consensus building,*** particularly in contingency and emergency decision-making and in authorising the nodal managers to interface outside the organisation within a collaborative matrix program.

" Inline" Management of Conventional Organisations .....



Issues : With "inline" the upper management executive instigates contracts with other organisations and authorises actions in a top-down way. At a working level within the divisions of those organisations there is a reiterative brainstorming for alternative solutions but they can not get their heads together because of the bottleneck of communications upline and over to the lead organisation. Final decisions should only go upline because upper management does not have the time, skills, nor resources at that level to coordinate an overflow of information needed in decision-making. Further, at working levels ideas are changing from time to time which inline managers are unable to tolerate.

" Crossline" Matrix Management for Programs and Projects .....



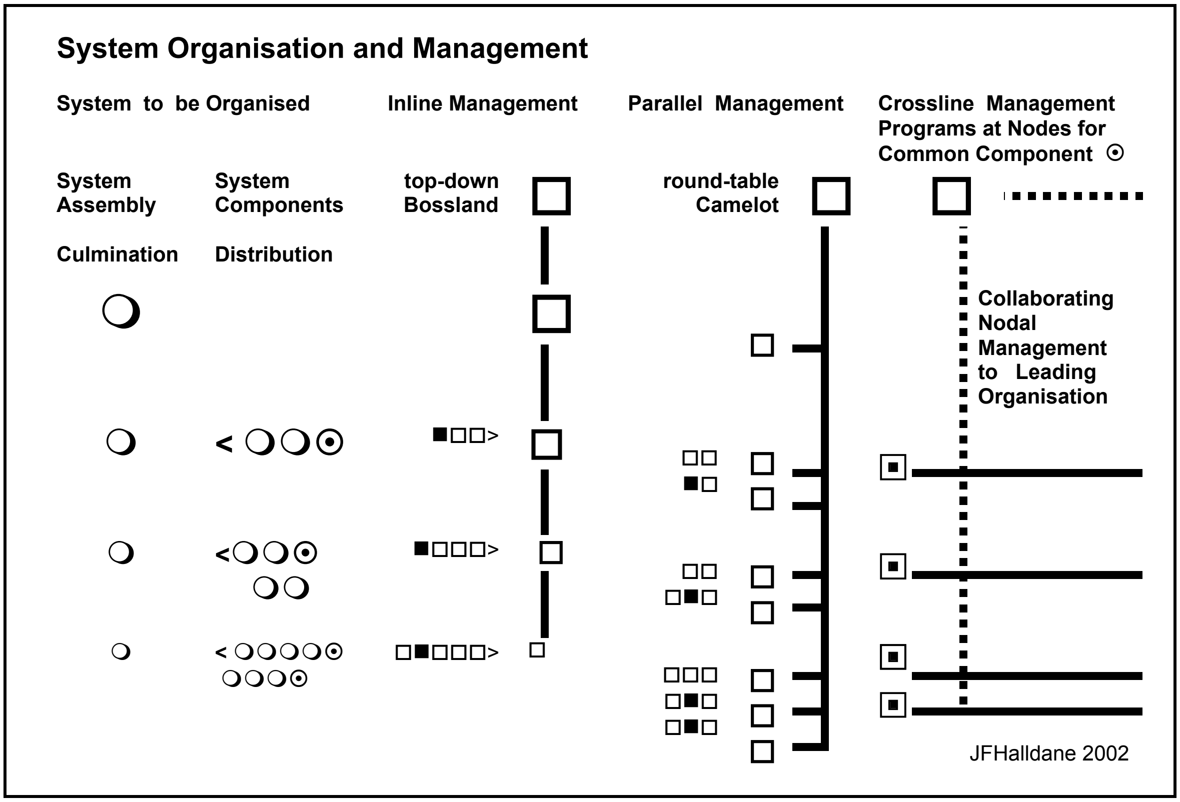
Solutions : Matrix Program Management, authorised by upper management executives, identifies the interdisciplinary team to work with, the Nodal Managers in each organisation, arrangements for inhouse duties and time, contracts and allocation of resources by all parties. Crossline Managers coordinate activity, brainstorm ideas, take initiative action, improvise where necessary, undertake investigations, testing, feasibility analysis, report up their lines with final decisions or recommendations for endorsement and record. The Program and Nodal Management Team must be competent, capable, enthusiastic,... acting with trusted authority from all the organisations involved. This way the lead organisation becomes an umbrella for program managers with all the resources decentralised in an effective collaborative administrative matrix and communications network

JFHalldane 1999, 2002

Crossline Management : Program Administration : Crossline management with its program administration is an ***inhouse across-the-organisation selection of experienced personnel and specialised resources*** for specific ***interdisciplinary programs*** in research, development and implementation. One administrative division may have the skilled professionals to do a job but another division may have the testing, reporting or logistics facilities for the job. As Chief of the Psychophysics Section, National Bureau of Standards in noise programs we were using the reverberation chambers in Applied Acoustics and for visual programs the internationally recognised experts in the Colorimetry Section. As a Senior Physical Scientist in the Federal Energy Administration I liaisoned with the across-the-board programs in Conservation, Oil and Gas, Geothermal, Solar, octane grading, and the economic PIES Program in Strategic Planning. Usually a designated qualified professional is delegated a job to do by their management. That person knows what resources to bring together and advises management what needs to be done. If that designated person is part of the upper management then the authorisation for the administration of that program is straightforward. However, lower echelon personnel must be authorised administratively to manage those interdisciplinary programs. This is best done by a ***"contract" or a "letter of agreement" between the parties involved*** to allocate the division of resources, technical support, budget and reporting requirements for the program.

Matrix Management and Administration for Collaborative Programs : Matrix management is a ***grid of programs*** that ***goes across*** the management of ***collaborating organisations***. It ***combines a crossline management in common programs*** with each organisation through their inline and parallel administration. It is an ***interagency or corporate crossline selection of experts and specialised resources from collaborating organisations for specific interdisciplinary programs***. A crisis occurs… a ***Lead Organisation*** evolves with a mandate to resolve that crisis… they liaison with Collaborating Organisations… those that can collaborate to identify the common links for resolving the crisis… personnel and resources are identified and ***grouped in Collaborating Nodes***… the Lead Organisation prepares a ***Program Plan or Business Plan*** upon which all the parties can agree to... they go about their common mission. Programs can wax and wane, be replaced, redirected, reorganised,… without disrupting the collaborating organisations. The FEA, Federal Energy Administration was created for two years to solve the consequences of the 1972-3 Arab Oil Embargo. This responsibility moved to ERDA then DOE, Department of Energy. A program budget can complement a nodal budget for that organisation, there can be an exchange of resources, but more significant is the inplace communication network for a rapid preemptive deployment of security to address the threats, breaches, reactions, recovery and countermeasures. Collaborating organisations can be government at any level, corporations, private enterprise, consultants,.. any group with the compatible expertise and resources. At the NBS, National Bureau of Standards we had across-agency "Tri-Service" programs with the military testing an actual townhouse in the huge thermal chamber, insulation on mobile cold storage units, noise in hospital corridors. There was one with DOT, Department of Transportation studying the auditory assessment of tire noise from vehicle passbys to endurance wheels. As an outside Consultant I managed, ran, measured, reported a steampipe test in the NBS Laboratory for a HUD Housing and Urban Development program. NASA, National Aeronautics and Space Administration got a man on the moon with crossline matrix management between corporate and government organisations. Again, inter-organisation "agreements" must be established for this mutual collaboration, particularly to reduce the bureaucratic protocol and to authorise the nodal managers to respond appropriately within the propriety of the contingency

or emergency and the organisation's security. Principles and use of Matrix Program Management and Administration are well established, responding well with flexibly to crisis situations..



Planning for Programs and Business Enterprise :
Outline of Topics

Title :	Suggests what the program and business enterprise is about …
Authority :	Plan authors with authorisation, on who's behalf, what for, disclaimers. …
Contents :	List in way people want to read the plan …
Summary :	Key features for each section noted on one page…
Description :	Enthusiastic outline of program and business enterprise with illustrations, opportunities and constraints, …
Theme :	Mission statement, objectives, unique distinctive features of program and enterprise, …
Marketing :	Program collaborating organisations, comparables, benefits, promotion,…
Production :	Mission, benefits and revenues; supply meets mission and demand in time,..
Management :	Planning, programs, projects, collaborations, commissioning, operations, maintenance, upgrading, matrix management , …
Financials :	Budget and Revenue, production, overhead forecasts then financial statement with profit and loss projection, cash projection, balance sheet, …
Evaluation :	Backup reports, statements, significance of information …

JFHalldane 1991, 2001

Leading Organisation : The Leading Organisation for generating the programs to resolve the crisis must be seen as capable of doing the job but also ***independently separate*** from those parties with special conflicting interests in the crisis. You can expect an organisation to protect its turf and not to be self-critical. It is not going to tell the world where it goes wrong as that reflects failure, so you allow them an outward avenue in the matrix crossline programs to express what should be done well. In Asia I found you ***only talk about the positive "things to do",*** never the negative "things not to do". For example, you have seen elevator signs "do not use in case of fire"!… well what do you do? Be assertive, direct, "fire, go stair, now, elevator stopped". A further point we have found with professional groups is that they are unable to police themselves. Perhaps realising these issues the Office of Homeland Security has been formed as an independent organisation to lead us out of the security crisis. With crossline programs there is ***no need to transfer any agencies*** into the leading one ; instead decentralise in a matrix of programs using the best from what you need.

Collaborating Organisations : Collaborating groups must present their case, credentials and conflicts of interest for their expertise, capabilities and facilities in order to contribute to specific programs or projects. It is a two-way effort with the program organisers and other collaborators. The CIA, Central Intelligence Agency coordinates intelligence, then disseminates, evaluates and distributes reasoned information. These are covert operations by questionable means on questionable characters well outside the ways of civil patterns. This is essential input for exposing threats, contingency planning, preemptive action and countermeasures. Homeland would allow the CIA to do its job but at the same time disseminate and report in useful form for the public to expose likely contingent threats and breaches.The FBI, Federal Bureau of Investigation is just that, it investigates after-the-fact.. It is hard for them to be proactive as their world needs legal warrants issued upon evidence of the things they are investigating. However, their profiling of cases and response methods can help in security planning, particularly in forming preemptive countermeasures. The INS, Immigration and Naturalisation Service is a service that should encourage people to come to our country to become citizens; certainly their mandate is not to keep them out. Homeland Security could well deal with the job of keeping out the undesirable by developing contingent criteria for screening entry-departure. The OEP, Office of Emergency Preparedness is within Health and Human Resources. The FEMA, Federal Emergency Management Agency addresses emergencies in natural and technical disasters, major transportation accidents and now "terrorism". Note these agencies address the breach in security, the actions taken, mitigation of losses, recovery and countermeasures. They are interested in the probability of occurrence because they need to know the extent of the resources they have to rely on. They can not be involved with a chance of threat and contingency planning. Similarly, corporations with high security risks are required to have emergency plans. They are now confronted with new threats that need contingency planning to indicate which threats will cascade into an emergency that we can be prepared for. Our matrix programs can be our effective interface here.

Program Planning : Business Planning : There are two sides of planning in our present day economy. One is to resolve the ***program opportunities and constraints to achieve the mission*** at hand, the other to create resources through ***business enterprise to drive that program***. We see this in government planning for programs to create public services, then "privatise" by selling off those services as a going business. Postal and power went this way with dubious consequences in

some cases. My preference is to "corporatise" where government keeps their business for future revenues but contract out the management. We will need to think about corporatising programs later in Homeland Security in order to economically sustain their activities. There are fundamental topics in planning to address. these are outlined in the table to cover the title, authority, contents, summary, description, theme, marketing, production, management, financials and evaluation. It can be easily modified for the particular program.

Nodal Management of the Collaborative Matrix Program Plan : The Nodes are the intersections of the collaborating inter-organisation program crosslines with the organisation inlines. The ***input-output at these nodes*** is controlled by a resourceful, responsive, highly skilled, propriety sensitive ***Nodal Manager***. The whole program depends on this vibrant pattern of nodes for actions which in itself needs its own security. Those protocols must readily open to the trusted network but restrictive to intruders or the merely curious. We should solve problems without leaks in information and misinformation. My suggestion here is to ***confirm the consistency*** of the enquiry-response ***between nodes*** for legitimacy; a form of nodal accounting and personal acknowledgement of their good work. After awhile we will find a buddy system will evolve in the personal trust and co-operation between the nodal managers.

Systems : Systems are ways we ***think things relate and work***. The logic is based on cause and effect; change one thing and another responds in a systematic predictable way. Science depends on this consistency so we create "models" that explain the co-relationships in fixed rules. Our automated controls depend on this fact, providing they are working according to the wanted relationships. All our "analysis" of events searches for consistent relationships but the question is which model of behavior best simulates the task at hand. Even in physics we need to overlay separate independent simultaneous equations to the extent of the number of variables to get solutions. Typically we equate energy, forces, temperature differences, volumes… In financials we overlay projections for profit-loss, cash flow, assets-liabilities, then balance them. For building security, safety and control we install closed protocol proprietary BAS, Building Automated Systems, then to supervise those we overlay open protocol AIMS Automated Integrated Monitoring Systems. By adding "expert" systems of predetermined coincidences we get "conditioned" responses so that the monitoring becomes management. Now where an event may not happen all the time or when a number of events have to occur before a threshold is reached for it to happen, then we have ***probability models*** for the overall effect. My contention is that we should focus on those underlying switches that cascade the events, that is the root causes. Probability is based on random events, stochastic, normal bell-shaped Gaussian distributions. Where probability is limited say by replacement, repairs, bypass, obsolescence,… then we get Poisson distributions. These are all ***predictable probable patterns for emergency planning***. Now when we have sporadic events happening occasionally, those irregular isolated incidences, unpredictable, strewn around,… then we have ***sporadic models***. Earthquakes, eruptions, tidal waves, plague, insurgence,… all unpredictable but likely. However, there are ***cues as precursors to those sporadic events***. These ***cues come together in a trend analysis for our contingency planning***.

Manager Systems : Grouping and Sequence for Programs

_Providing Resources: Authority to manage program, contracts: delegate responsibility for use, operations, maintenance, upgrading: project co-ordination in cross-management, consultants, verifying commissioning, training management and technicians: supervise, situation initiative: inventory updates: track permits, warrantys, accounts, budgets: projective business planning, management planning: instal AIMS, LAN …System diagrams…
Flow charts for responsibility. spread sheets for events. inventories. reports.

_Monitoring Performance: Ensure work-fail-safe operations, appropriate use schedule maintenance, accommodate upgrading: supervise AIMS, BAS effectively: routine data recording, utilities, bills, logs, service calls, inventory, condition reports, automated response for system failure, security breach: inspect, audit, survey, test: warranty provisions …
Displays. data storage. reports. Schedules. automated emergency response alarm and control. "middle-third" regression statistics

_Diagnosing Operations, Use, Maintenance, Upgrades: Criteria for good-poor performance, limits: trace causes for alarms, outages, complaints, high utility bills, waste: system failure: management effectiveness: procurement quality: logistics, lift travel, user directory: technician know-how:: …Analytical models : sporadic for contingency, probability for emergency,…
Automated diagnostics. "expert" systems. calibration. independent condition verification. analysis for automated emergency response program. …

_Responding to Plan: Anticipate events: contingency planning, life emergency priority: equipment failure, security, safety, health, damage mitigation, specific contingency:reporting sequences, data verification: analysis of events: appropriate action: …
Automated response to programmed events. decision trees and confirmation nodes.

_Designing Better Alternatives: Practical scenarios from manager system feedforward: consultant review, contractor ideas: question reliability of products, see demonstration, past experience, backup services, user-friendly: design integration for better performance: Computer design aids. Files. overlays of better alternatives. animation of event sequences.

_Evaluating Situation, Improvements: Evaluate improvements to design, response, diagnostics, monitoring, resources provided: trend analysis for good-poor performance, questionnaires, technology assesment, environmental impact, performance testing: progressive specifications, design and performance specifications: compliance with regulations, codes, standards, ordinances: conservation power, energy, water, sewage, refuse, resources, life cycle costs: feasibility analysis, priority setting, budget, decision making, matrix management, critical path, programming: justifications: …
Evaluation and computer applications common in planning, engineering, architecture, economics, management, offices…

_Implementing Changes: Undertake changes decided from evaluation, design, responses, diagnosis, monitoring, resources: program or project management for construction: commissioning: supervision: worker initiative,operator manuals: warranty provisions: contract requirements: …
Schedules. critical path. installation testing. condition reporting. contract logs. …

_Adjusting Performance for Program-In-Action: Fine-tune the program-in-action: difference testing for peak performance, balance loads: improve manager system cycle: Realtime monitoring. resetting control criteria. performance verification and modification for working conditions to best performance for program-in-operation, facility-in-use.

JFHalldane 1991, 2001

Management Systems : What helps a manager organise their responsibilities ? It is well known that a person can not do everything at once, in fact the brain time-shares information even between the sensory modes, depending on what dominates the perception of their space and form in time. In organising management we follow the sequence of the things being organised. If a process, it is often in departments in the line of the process, such as in form filing, banking, manufacturing, etc. Our computer now has many formats for spreadsheets, accounting, inventory, reporting, applications,… So this has traditionally favored the inline, hierarchical organisation. This has all changed with mission oriented programs. It started from the World War 2 era where we had to organise a whole lot of huge things simultaneously, then suddenly bring them all together and guarantee they would work in the field ; lives depended on it.

Standardisation, component and system testing, trials, human factors, co-operation, planning, forecasting, training,… all followed. It was matrix management to accomplish a common mission. The saga continues today. We ***can handle the predictable emergencies*** relatively well, however the major difference is that we are ***now confronted with contingencies in unknown, unpredictable threats***. For Homeland Security today the ***new direction is in sensing the cues for threats in contingency planning which may in turn cascade into breaches and emergencies*** of a different character from what we are used to. Contingency planning is the main focus for our manager systems. We must have systems for a ***heuristic discovery of the sporadic cues*** to be ***correlated in trend analysis*** for our contingency planning. This would arm the Nodal Manager with ***automated contingency systems*** that can scan the field for threat cues, integrate likely cascades from trends, feedforward, confirm for nodal consistency, issue alerts for pending breaches, modify with feedback, transfer to an emergency mode where appropriate. An outline of manager systems is noted in the table which covers providing resources, monitoring, diagnosing, responding, designing, evaluating, implementing, adjusting the programs for each node.

. . . sensing the cues for threats . . .
. . . systems for heuristic discovery of those sporadic cues . . .
. . . to correlate in trends . . . . . for contingency planning
. . . automated for continuous scanning . . .

Conclusion . . .

Matrix management in crossagency collaboration can select the best for relevant security programs without the disruption of our present administration.

The mission success rests in the appropriate competent actions of the decentralised nodal managers.

Homeland Security programs require a different approach to management, especially in contingency planning. These new ways involve feedforward, heuristic discovery of threats in cues from sporadic events, and trends that lead to actual breaches in security. This should not be confused with the parallel programs in the probability of breaches in security for emergency planning, then the reactions, recovery and countermeasures.

Acknowledgement . . .

It is my pleasure to have the opportunity to contribute to the ONR Workshop with this urgent national topic.

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6. **Building collapse: Contingency planning for prediction, precautions & procedures as a facility management system**. John F. Halldane, Ben Ericson, Salil K. Roy, Miguel Baltierra. Proc. South Pacific Reg. Disaster Conf., Australian Inst. of Tropical Architecture, James Cook Uni. and PNG Univ. Tech., Lae, Papua New guinea. 16-18 June 1994, p1-15.

7. **Predicting building collapse.** John F. Halldane, Salil K. Roy, Nat Khublall, C.K. Murthy, S.D. Ramaswamy. ISI-CTBUH-TBM 2001, Paper 29b. . ISI-UTM Int. Conv., Inst. Sultan Iskandar, Hotel Istana, Kuala Lumpur. Paper 08.10, 24-26 Jan 94, p1-20

8. **Indoor air quality and contaminant exhaust: Health. behavior. perception, distribution, control, management.** John F. Halldane, M.Ansar Haque. ISI-CTBUH-Urban Habitat and Highrise Monograph TBM.Vol.b. 2001, Paper 1b. Comprehensive discussion of contaminants and the exhaust rate, air change by 'half-life' time. Discovered "stuffy" relates to CO2 over 1000ppm; "headache" and "irritation" to CO over 1.7ppm and formaldehyde over 0.2ppm; "sleepy" to hydrocarbons over 1.1ppm. Also "musty" could relate to hydrocarbons of fermented alcohols and "pissy" to the ammonia of urine. Air movement needed to remove sweat in humid tropics; suggests terminal downward air jets, night air purging, control sensors CO2 for exhaust and CO for intake when ambiant right. Measurement and facility management discussed.

9. **Water use, contamination, testing and treatment.** John F. Halldane. ISI-SEACEUM-7, 2001, Paper 15, p183-198. ISI-CTBUH-TBM, 2001, Paper 30b Comprehensive coverage water isues, solutions, tracing nutrients-contaminants, health effects, water testing, criteria, instrumentation, water treatment, chemicals, contaminant removal technology.

10. **Behavioral psychology in life-quality planning and urban design: Purrs in happy-town?.** John F. Halldane, ISI-SEACEUM-8, Sep 2002. Outlines responses of people-cat life, the stimulus scenarios and settings, then the responses of enquirer and designer. Goes over impression-demonstration-interview phases of enquiry. Sets out life-quality indicators and criteria for marketing the urban enterprise.

11. **Homeland security through a decentralised matrix management.** John F. Halldane. 4th Annual ONR Workshop on Collaborative Design-Support Systems. Office of Naval Research. Hosted by CADRC, Collaborative Agent Design Research Center. at Quantico. Marine Corps Base. Virgina. Sept. 18-19, 2002

Collaborative Role of Data Analysis and Inspection Technology in Improving Supply Chain Security

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University College and Extension Services
California State University, Long Beach
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Abstract:.

The combined Los Angeles and Long Beach port complex is the largest in the United States and the third largest container port complex in the world. In 2000, the port complex handled 9.5-million Twenty-foot Equivalent Units (TEU) of cargo which constituted 35% of all waterborne container cargo in the US. Established in 1977, the Center for International Trade and Transportation (CITT), California State University, Long Beach, is designated a multi-disciplinary center for intermodal transportation studies and integrated logistics research, education, training, policy analysis, and technology transfer by the U.S. Congress. The authors and others at the California State University – Long Beach have for some time conducted research on surface ocean transportation, port of entry and exit inspection process, and integrated approach to managing shipping containers, with particular emphasis on high-speed sealift, terminal operation, and application of new technologies.

The trans-Pacific supply chain is not only significant to the regional populace and businesses, but also a critical national infrastructure resource with linkage to the global economy, particularly commercial suppliers and businesses. Furthermore, the port complex is vital to support our military deployment and operation. The supply chain agility is indeed a central theme to the successful operation of the vast goods movement enterprise. In view of the heightened Homeland defense and security, we are challenged to identify opportunities to enhance the supply chain and operational processes, and, at the same time, reduce vulnerabilities to the supply chain.

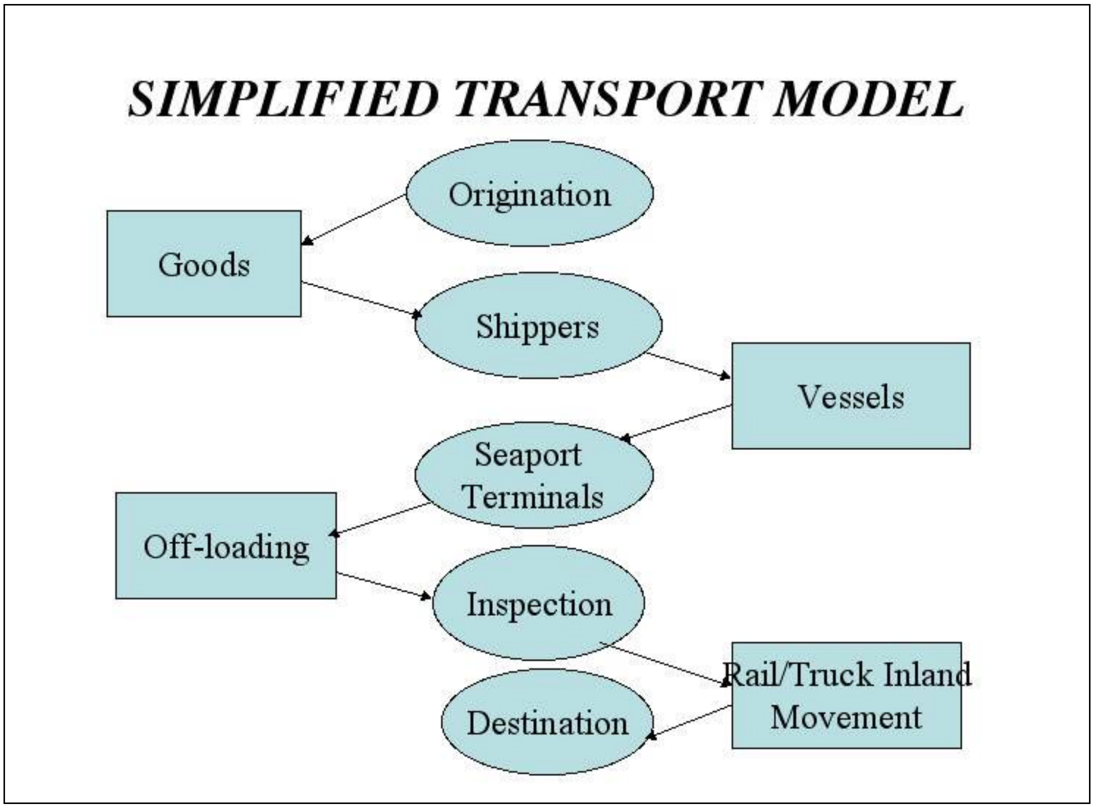
This presentation has the objective to highlight the importance of an integrated approach to the Southern California regional supply chain for goods movement by presenting on-going projects in goods movement and inspection technology and associated pilot technology and logistical demonstration efforts. To sustain growth in the region, we enlist the support of stakeholders (e.g., suppliers, shippers, port and terminal operators, inspection agents, and manufacturers, etc.) to collaborate in supply chain management. The key to collaboration is based on shared values; proper application of new technologies such as real-time monitoring; sound public policies; and efficiencies in goods movement including management of "weakest links". We will present supply chain vulnerabilities and weakest links through our systematic analysis and to apply threat reduction techniques or risk management concepts, thus ensuring contingency plans are in place to enhance supply chain security and to maintain a robust goods movement in the region.

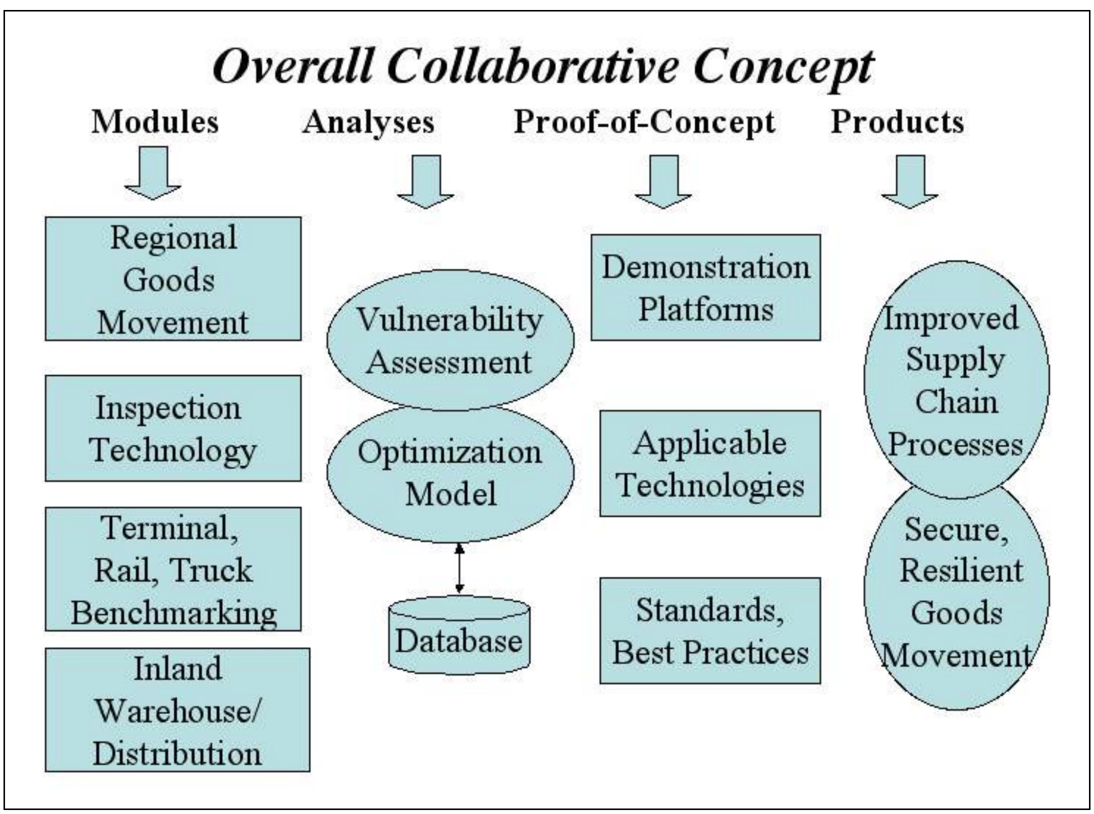
OUTLINE

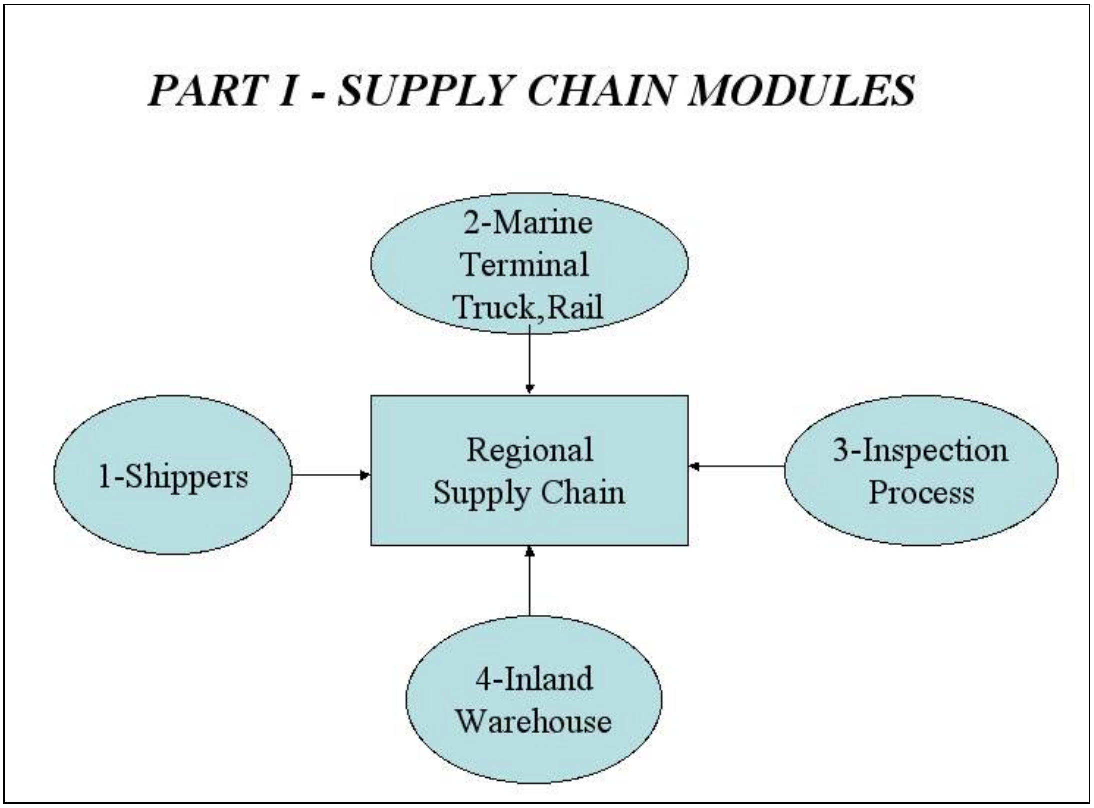
- Objective: Present collaborative approach to Southern California regional supply chain and commercial and military goods movement
- Center for International Trade and Transportation and related research
- I - Regional goods movement supply chain model
- II - Vulnerability analysis of supply chain
- III - Common high-risk container inspection facility
- Next steps

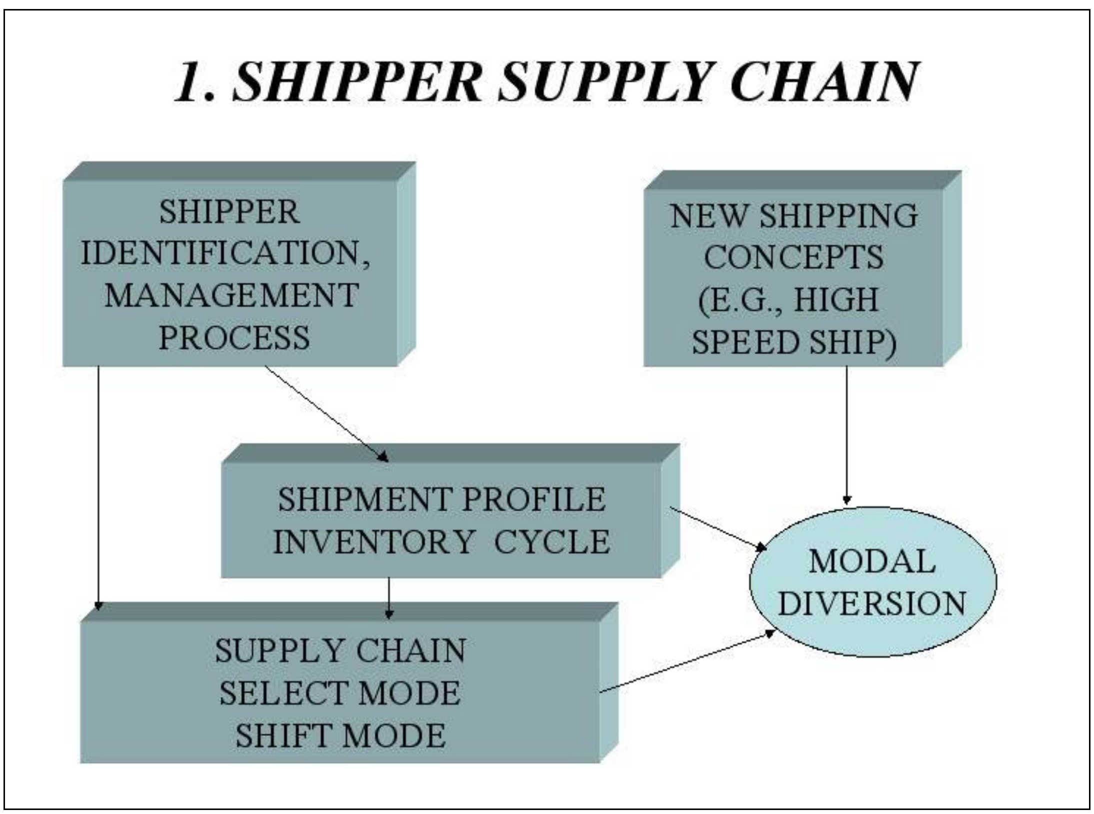
Center for International Trade and Transportation

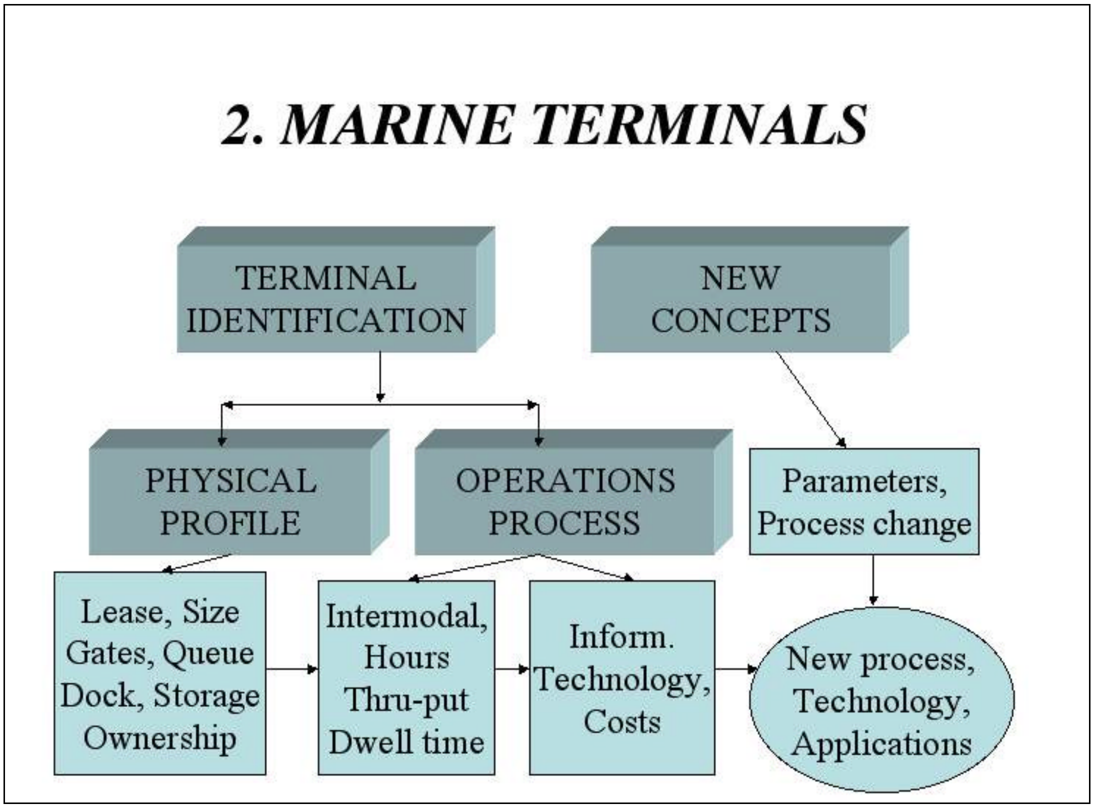
- Established in 1977 at California State University, Long Beach, California
- Designated a multi-disciplinary transportation research center by U.S. Congress
- Specializes in intermodal transportation studies and integrated logistics research, education, and technology transfer

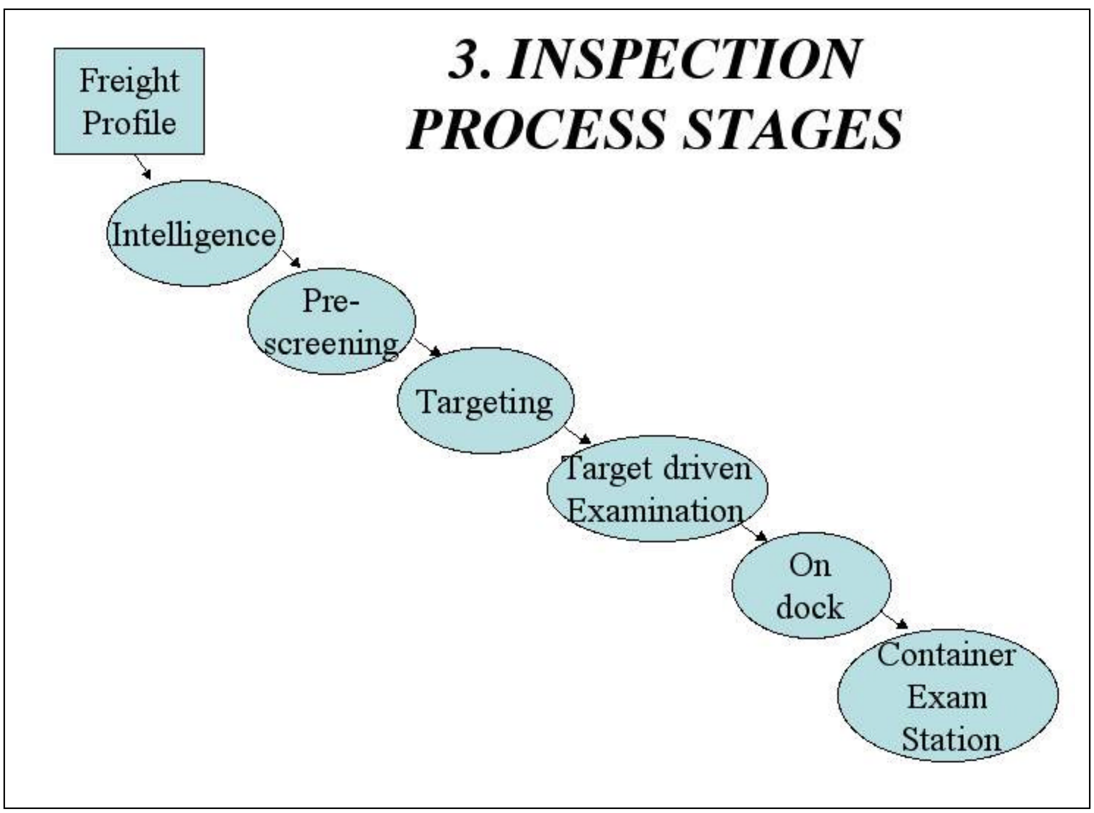

SIMPLIFIED TRANSPORT MODEL
Origination
Goods
Shippers
Vessels
Seaport Terminals
Off-loading
Inspection
Rail/Truck Inland Movement
Destination


Overall Collaborative Concept
Modules
Analyses
Proof-of-Concept
Products
Regional Goods Movement
Inspection Technology
Terminal, Rail, Truck Benchmarking
Inland Warehouse/ Distribution
Vulnerability Assessment
Optimization Model
Database
Demonstration Platforms
Applicable Technologies
Standards, Best Practices
Improved Supply Chain Processes
Secure, Resilient Goods Movement

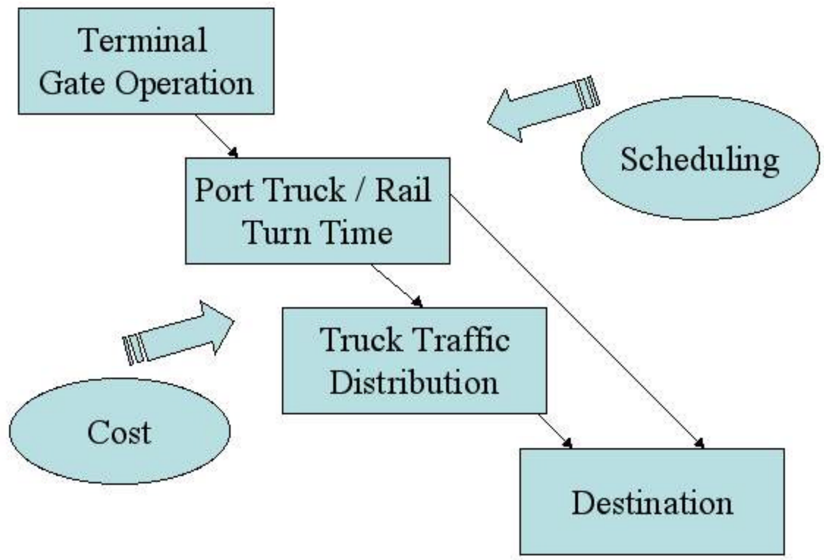

PART I - SUPPLY CHAIN MODULES
2-Marine Terminal Truck,Rail
1-Shippers
Regional Supply Chain
3-Inspection Process
4-Inland Warehouse


1. SHIPPER SUPPLY CHAIN
SHIPPER IDENTIFICATION, MANAGEMENT PROCESS
NEW SHIPPING CONCEPTS (E.G., HIGH SPEED SHIP)
SHIPMENT PROFILE INVENTORY CYCLE
MODAL DIVERSION
SUPPLY CHAIN SELECT MODE SHIFT MODE


2. MARINE TERMINALS
TERMINAL IDENTIFICATION
NEW CONCEPTS
PHYSICAL PROFILE
OPERATIONS PROCESS
Parameters, Process change
Lease, Size Gates, Queue Dock, Storage Ownership
Intermodal, Hours Thru-put Dwell time
Inform. Technology, Costs
New process, Technology, Applications


3. INSPECTION PROCESS STAGES
Freight Profile
Intelligence
Pre-screening
Targeting
Target driven Examination
On dock
Container Exam Station

4. INLAND QUEUING SUBSYSTEM



Examples - Regional Goods Movement Flows

A Portray marine terminal berths, on dock rail and truck gates as series of "gates" or queues

A Utilize current freight data (ACTA) as baseline for total throughput, import and export flows, and mode splits

A Develop average transit times between gates for other types of flows

A Calculate average dwell times (import,export,empty container) for each gate

Examples - Regional Goods Movement Flows

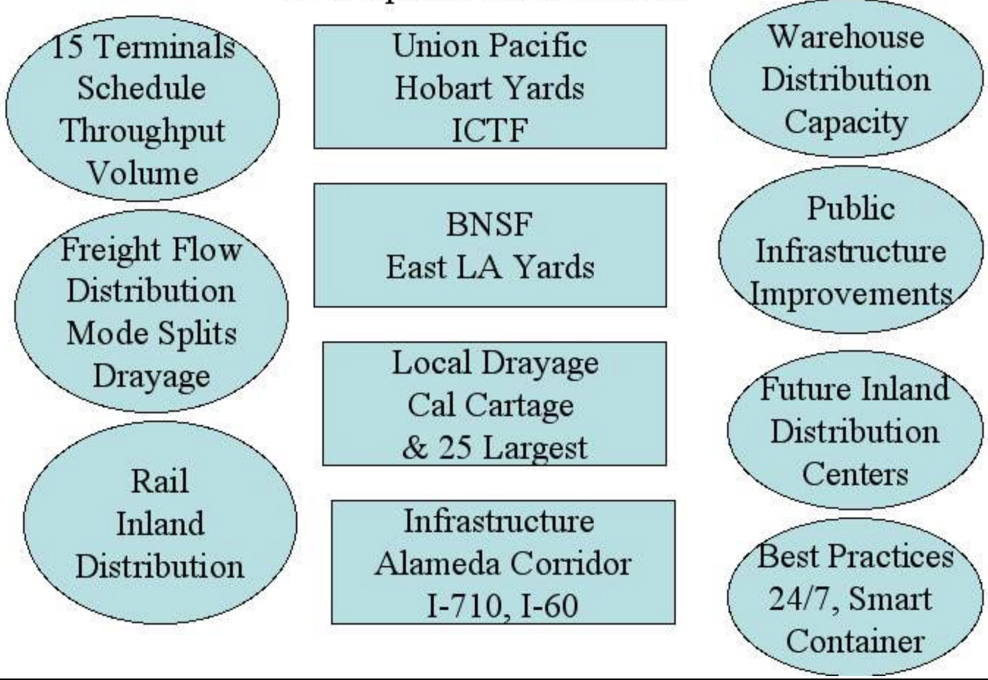
Extend truck dispatch for terminal pickup to rail and inland warehouse facilities

Recommend measures or system compartmentalization to restore system operation in event of incident

Use RFID tagging and tracing capability and sensors at gates to verify gate flow on real time basis

Track by container number and chassis number data elements

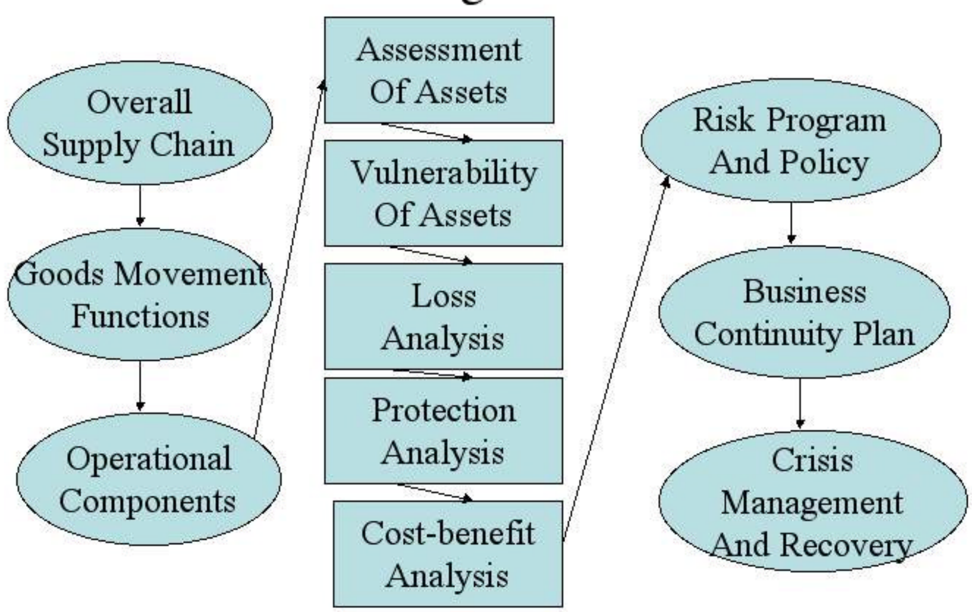
Regional Goods Movement Freight Flow and Optimization Model



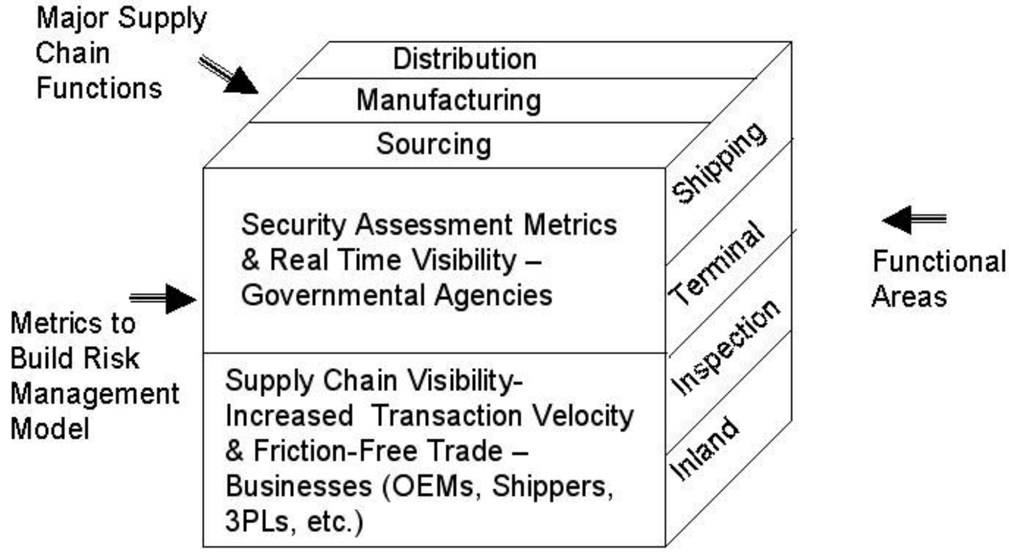
Part II - Supply Chain Vulnerabilities and Cascade Effects

- *Highest Level* – Overall Supply Chain (Resiliency)
- *Functional Level* – Sourcing, Manufacturing, and Distribution (Friction)
- *Operational Level* – Suppliers, Shippers, Carriers, Terminal Operators, Inspectors, Freighters (Throughput and Costs)
- *Technologies* – Seals, Trusted Shipper, A.I. Targeting, Non-intrusive Scanners, Information Technologies (Risk Management Metrics)

Risk Management Process



The 3- Dimensional Vulnerabilities Assessment Model



Ram Reddy

VULNERABILITY ASSESSMENT

Catastrophic

- Business operations is disrupted for weeks/months.
- Example - Disablement of a functional area (shipper, terminal, etc.)
- Consequence - firms seek alternate sourcing, distribution & manufacturing sources.

Major

- A functional area is unavailable temporarily (days or weeks)
- Example - troop deployment, etc.

Minor

- A facility within any functional area is unavailable for hours/days.
- Example - rail or crane accidents at ports, etc.

Approach

- Extend work done in the functional areas by CITT to vulnerability analysis.
- Focus on selected shippers & 3 PL to generate metrics of value for the model.
- Develop sourcing, manufacture and distribution metrics of value for increased visibility and contingency planning with trusted shippers
- Conduct workshops and table top exercises with Governmental agencies to validate/develop assessment model.

Value of Vulnerability Model

- Pinpoint boundaries for supply chain assessment of vulnerabilities.
- Define vulnerabilities in terms of security and trade needs.
- Identify vulnerabilities and develop contingency plans in case of disruptions.
- Formulate public policies to achieve goals of increased security with decreased friction in global trade.

"Pushing the Border Out:"
Creation of the "Virtual" Electronic Border

Rob Quartel
CEO and Chairman, FreightDesk Technologies
Former Member, US Federal Maritime Commission

Abstract:

International trade is a tremendously complex business, but it generates within itself the means to protect it through sophisticated electronic data and information processes.

A typical international transaction will have as many as 20-25 involved parties – buyers, sellers, inland transporters on both sides of the ocean, ocean and other water carriers, middlemen, financiers, governments and others – and will generate 30-40 documents. Some 6 million containers, many carrying cargoes for multiple owners and valued on average at $60,000 each, entered the US in the year 2000, on ships carrying from 3-6000 containers each. Literally millions of people and hundreds of thousands of companies worldwide are engaged in the business of moving cargoes internationally. In the US alone, there are an estimated 400,000 importing and exporting companies, 5,000 licensed forwarders and customs brokers, perhaps as many as 40,000 consolidators large and small, and millions engaged in the transportation industry. Worldwide, there are at least in theory some 500 ocean carriers – although probably 10-15 carry 90 percent of cargoes shipped between continents – an estimated 50-70,000 forwarders and tens of thousands more intermediaries, not to mention several million companies moving goods.

<u>This is a process that literally spews data – data on the contents, on who touched the cargo, who paid for it, where it's been, where it's going</u>. And it's a process into which commercial shippers – the people who own, buy, or sell a cargo – tap into daily, in one form or another, to collaborate on transportation and financial transactions, to exchange documents, to meet regulatory requirements of the various jurisdictions in which they operate, in addition, of course, to documenting the basic buy-sell transaction that begins the shipment. <u>For the most part, every bit of the data and information generated by this process is available – somewhere and in some form -- but not necessarily captured in one place by the private sector, and certainly not by the US government</u>.

The author, in October 2001, proposed the creation of a "virtual" border – a concept known as "Pushing the Border Out"– in which information generated throughout the trade process would be captured in a data warehouse, combined with US government intelligence and law enforcement data in a new government-run "fusion center," and analyzed using sophisticated forms of artificial intelligence and profiling to provide government and commercial operators with a means of ascertaining levels of risk associated with individual shipments PRIOR to their loading onto a ship bound for a US port. Under this concept, all international cargos bound for the United States – as well as outbound cargos – would be "opened" electronically first, prior to the layering of other security technologies and practices, and evaluated for risk. Much of this proposal has been written into various pieces of legislation now pending before the Congress, and into proposed regulations governing US trade.

Proprietary

The Problem

The United States does not have an effective integrated process to counter the use of ***commercial containers*** *as terrorists' weapons to attack US Ports and intermodal transportation nodes*

17 Million Containers Per Year

Intermodal Threat Vectors

Less than 2% inspected

Containers: An Attractive Terrorist Weapon

- Automated processes
  - Minimal inspections at both ends
  - Senders ability to mask identity
  - Carried by trusted ship and crew
  - Volume and distribution – needle in a haystack
  - Once aboard ship – massive disincentive to divert
- Multiple payoff – loss of life/economic disruption/simultaneity of attack
  - Container can be weapon of mass destruction or smuggle weapons
  - Precision targeting with GPS trigger
  - Cargoes large and heavy or hidden and small
  - Access to port and inland targets via intermodal system

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Three Tenets Underlying A Solution

- Every shipment/container is a potential weapon
- Every port is both a target and a gateway
- Every ship, truck, train, plane could be a delivery vehicle

CONCLUSION: Every shipment and every container should be inspected, prior to loading, either physically or electronically, or both; and its integrity and chain of custody maintained from loading to delivery to prevent further tampering.

Corollaries

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Corollaries

- This is about transportation and logistics, not borders and oceans.
- This is both an international AND a domestic problem
- This IS NOT a compliance (Customs) problem: **A legal cargo can become a lethal cargo**.
- The port is a node within the process, not even the most important focus for security.
- Profiling should begin in the United States with the issuance of the purchase order from the buyer.
- Make the shipper responsible for the process.
- Commercial Data can tell you:
  - Cargo – What is being transported?
  - Carriers – Who is handling the cargo?
  - Conveyance – What is the route, how is it moving?
  - Commerce – Who are the parties to the transaction?

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Emerging New North-South Double -Stack Intermodal Rail Corridors

* for the region

Source: Double-Stack Container Systems: Implications for U.S. Railroads and Ports, U.S. DOT/VZ/TranSystems

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Port Range (Multiple Ports) Competitive Capacity Maps - Example

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Proposed Solution: Create a Virtual Border

- *"Profile"* every container bound for a US destination before loading
- Develop normalized database(s) from commercial and government sources
- Create a single Center for Data Fusion
- Employ high tech computer power and sophisticated algorithms and pattern recognition techniques to ID high risk containers

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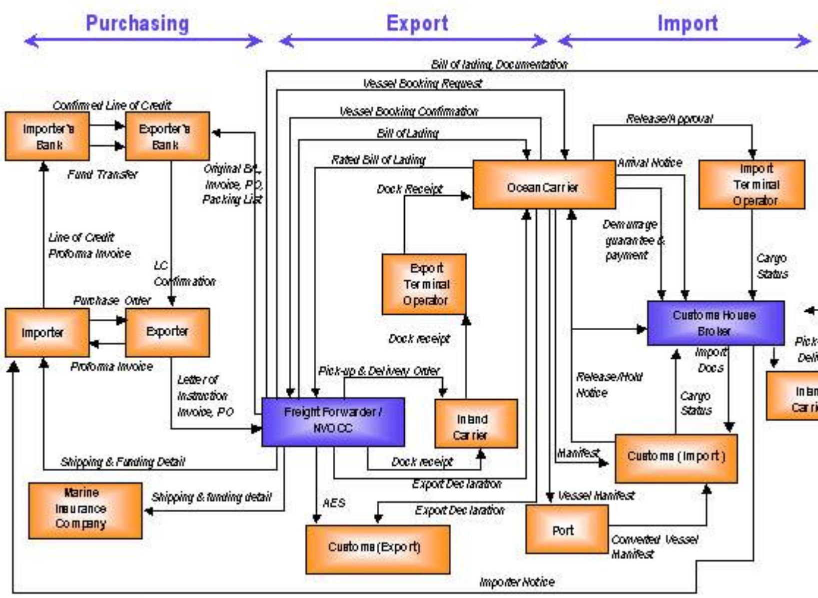
Trade is a Complex Process



- Up to 20 Involved Parties
- 200+ data elements
- Manual data exchange processes
- Multiple data platforms
- 30+ documents or messages

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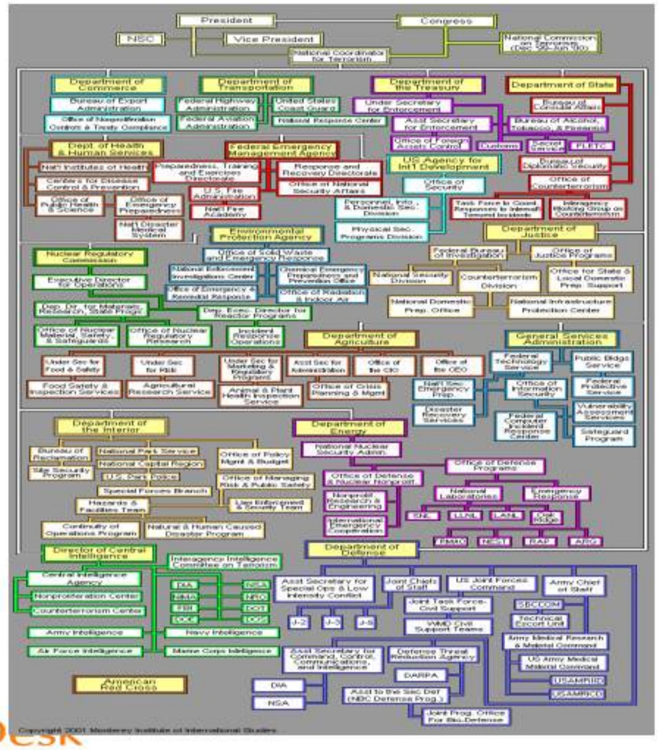

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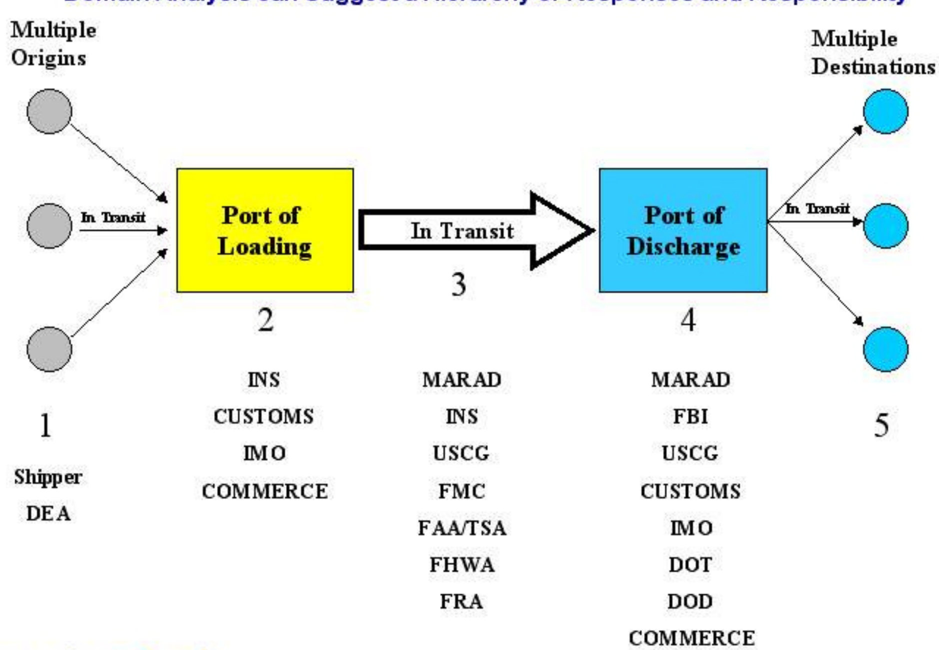
International Freight Movement: Five Domains

Domain Analysis can Suggest a Hierarchy of Responses and Responsibility



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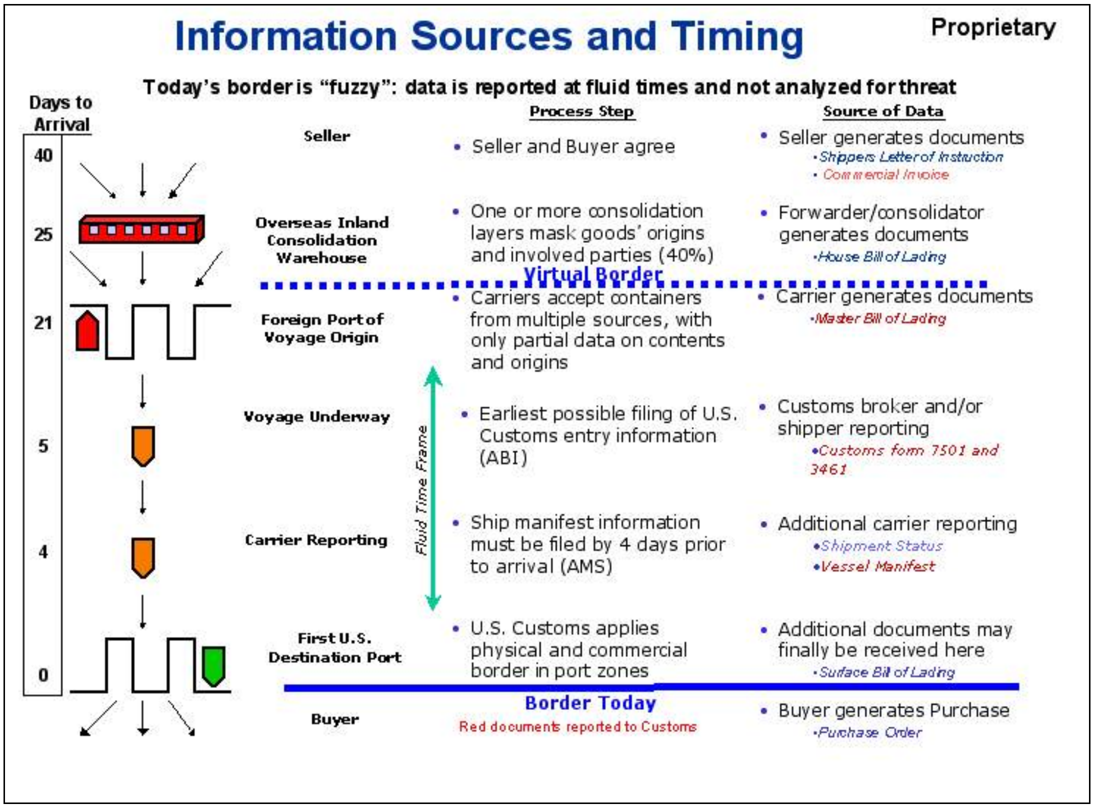

"Sum Of All Fears" import of WMD

Movie Scenario

•Cargo crate with nuclear device loaded in Illychevsk

•Transhipped in the Canary Islands

•Unloaded in Baltimore

•No Customs Clearance

•Delivered from port to Ground Zero by inside player

•Cargo Manifest tracked by CIA back to origin

Scenario Today

•Cargo would be delivered to customs bonded facility

•Must be customs cleared or delivered by bonded trucker to another bonded facility

•Would have to have customs paperwork to be released, form 7501, 3461

•Movie scenario could not be executed, with cargo stuck in port, however, port could be target with similar consequences

Profiling Scenario

•Prior to loading in Illychevsk or Canary Islands check Involved Parties – arms dealer is the shipper –red flag

•Is it consigned to a real company – no – red flag

•Does the cargo documentation check out? No – cigarette machine made in Ukraine – red flag

•Banking information – who paid for shipment – red flag

•Above issues all point to stopping shipment prior to embarkation

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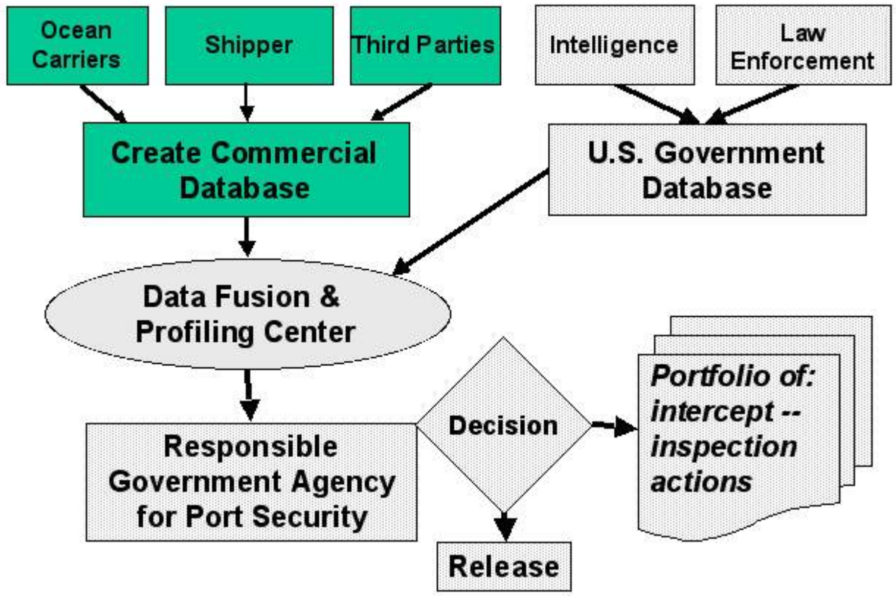
Profiling Approach



Data Mining to Assess Risk and Identify Potential Threats

- Synergistic array of data mining techniques
  - Statistical patterns and profiling
  - Mathematical models for risk assessment and threat identification
  - Evolutionary algorithms to detect changes in patterns and discover new patterns
  - Knowledge base, both specific and general
    - Based on rules and known facts

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Customs Information Contains Many Data Elements. BUT: Successful Profiling Requires More Data, Earlier

Manifest information

- Bill of Lading Number
- Shipper, Consignee, Notify Parties
- Container Numbers, Weights and Dimensions
- Cargo Description and Harmonized Nomenclature
- Hazardous Material Information
- Port of Origin, Unloading, Final Destination
- Vessel and Voyage Information

Full Data Element Capture

- Routing and carriers prior to delivery to import carrier
- Full Involved Party Listing; Forwarders and Manufacturers
- Letter of Credit Information; Bank names and information
- Consolidation Information
- U.S. Inland Delivery Routing
- Unit Cost of Items

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Examples of Anomalies that can be checked using data currently available

Anomaly	Commercial Document	Data element for Anomaly
Cargo Incongruent with Origin	Commercial Invoice, Master Bill of Lading	Routing, Item listing
High value cargo and slow mode	Commercial Invoice, Master Bill of Lading	Item values, routing information
Document discrepancy	Any	Documents do not conform to each other
New Shipper or Consignee	Commercial Invoice, Bill of Lading, Certificate of Origin	Shipper or Consignee Sections
Violation of established shipping or commercial patterns by parties	Any	Any – more in timing/receipt of documents (ex. Once-a-week shipper ships twice in one week)
Suspect source area and transship to small ship	Shippers Letter of Instruction, Bill of Lading	Origin of cargo, route
Point of origin	Shippers Letter of Instruction	Pickup location
Illogical commercial transactions	Commercial Invoice	Comparison of Consignee and Cargo (ex. Furniture company receiving garments)

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Sample U.S. Import Documents with Major Data Elements

	Data Elements	Used Before Shipment: Pro-Forma Invoice	Packing List	Certificate of Origin	Shipper's Letter of Instruction	Insurance Certificate	Inspection Certificate	Letter of Credit	Used During Shipment: Commercial Invoice	Transmittal Letter	Customs Form [illegible]	Bill of Lading	Inland Bill of Lading	Vessel Manifest	Delivery Instruction	Customs Form [illegible]
1	Invoice Number	x							x							
2	Date of Issuance	x							x							
3	Shipper's/Exporters name & address	x	x	x	x	x	x	x	x	x		x	x	x	x	
4	Exporter Identification Number (EIN)				x	x	x	x				x	x	x	x	
5	Agent of Exporter				x	x	x	x				x	x	x	x	
6	Intermediate Consignee's name & address	x	x		x	x	x	x	x	x		x	x	x	x	
7	Ultimate Consignee's name & address	x	x	x	x	x	x	x	x		x	x	x	x	x	x
8	Quantity	x	x	x	x	x		x	x	x	x		x	x	x	x
9	Unit Price	x	x		x	x		x	x		x		x	x	x	
10	Total Price	x	x		x	x		x	x	x	x		x	x	x	x
11	Net Weight	x	x	x	x	x	x	x	x				x	x	x	
12	Gross Weight	x	x	x	x	x	x	x	x		x		x	x	x	
13	Description of Merchandise	x	x	x	x				x		x					x
14	Terms of Payment	x							x	x						
15	Incoterms	x			x				x	x						
16	Estimated Shipment Date	x														
17	Currency of Payment	x						x	x	x	x					
18	Time Limit	x						x	x							
19	Miscellanious Charges (FCA, CIF)	x						x	x							
20	Letter of Credit Number							x	x	x						
21	Letter of Credit Date							x	x	x						
22	Import License number								x							
23	Harmonized Commodity number				x				x							x
24	Ocean Carrier Name			x					x		x	x		x		x
25	Ocean Carrier Route								x			x		x		
26	Voyage Number										x	x		x		x
27	Vessel Flag													x		
28	Foreign Port of Export										x			x		x
29	Loading Pier													x		
30	Port of Unloading										x			x		x
31	Method of Transportation															
32	Country of Ultimate Destination				x						x	x				x
33	Bill of Lading Number							x	x							
34	Marks, Nos. & Kinds of Packages		x	x	x											

Sample Data Elements and Application Data

Carrier/Party Data

Leg Data

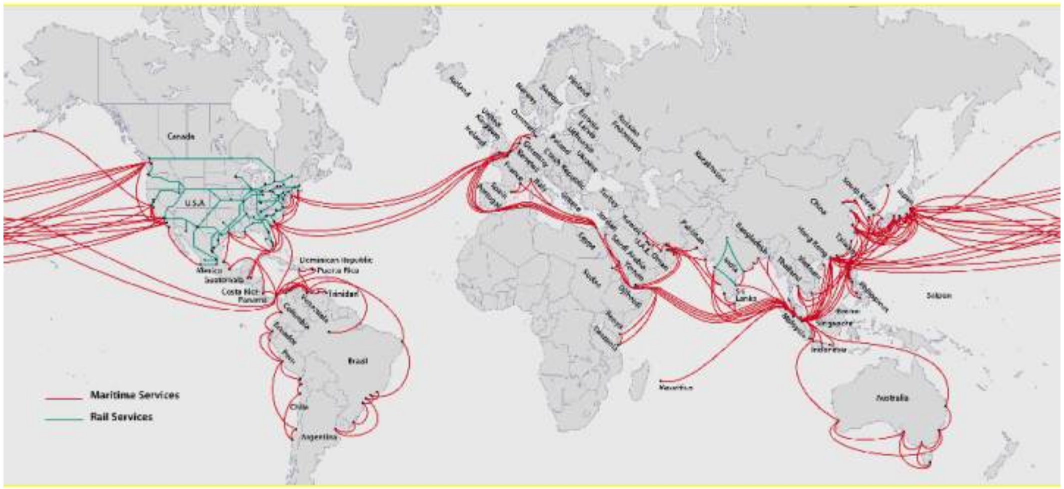
Route Data

	Data Elements	Buyer	Seller	Supplier	Export Forwarder	Carrier	Import Forwarder/ Broker	Consignee
Carrieres/Parties Data	Shipper's/Exporters name & address	x						
	Supplier		x					
	Agent of Exporter/Packer		x					
	Inland Carrier (origin)		x					
	Ocean Carrier Name				x			
	customs broker							x
	Inland Carrier (Destination)					x		
	Delivering Carrier (destination)							x
	Seller's Bank name & address	x						
	Buyer's Bank name & address	x						
	Intermediate Consignee's name & address				x			
	Ultimate Consignee's name & address	x						
Conveyance Data	Country of Origin	x						
	Point of Origin (City & State)	x						
	Method of Shipment to Forwarder		x					
	Inland carrier route (origin)		x					
	Ocean Carrier Route				x			
	Voyage Number				x			
	Vessel Flag				x			
	Foreign Port of Export				x			
	Country Which Shipped				x			
	Loading Pier					x		
	Transhipment Ports					x		
	Port of Unloading				x			
	US Port of Arrival				x			
	Inland Carrier Route (destination)					x		
	Delivering Carrier Route (destination)							x
	Country of Ultimate Destination	x						

At time of Purchase Order | Prior to shipment | En route to port of export | On water/after arrival US

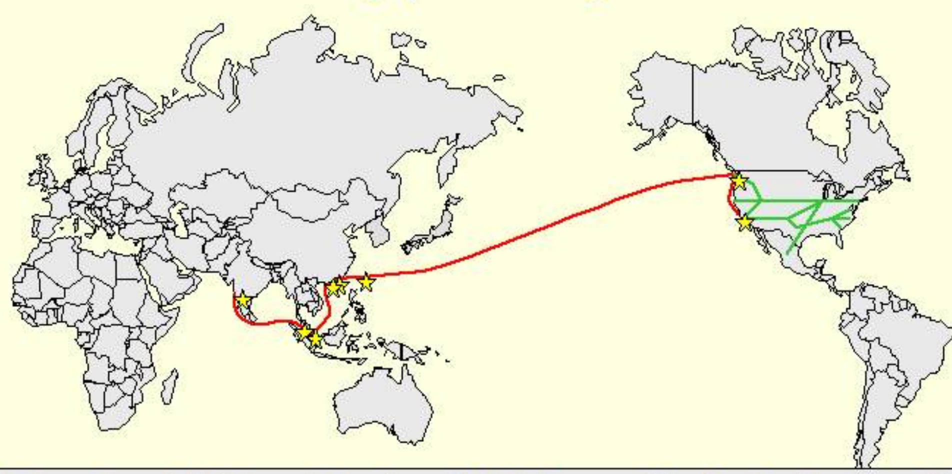
Proprietary

APL Trade Routes: Global Reach



Proprietary

Notional Demonstration Route
APL Singapore – Long Beach



The above schematic illustrates a single route applicable to the proposed Los Angeles – Singapore profiling demonstration concept. APL's global reach and transportation infrastructure provides an outstanding demonstration setting. For example, a 20' container may depart Nhava Sheva, India & relay (on the same voyage & service) through Port Kelang, Malaysia ~ Singapore ~ Yantian, PRC ~ Hong Kong ~ Kaohsiung, Taiwan, arriving Seattle, WA 10 days later, and an additional 4 days to Los Angeles, CA. The container could then depart the US West Coast using the North American intermodal systems & networks across and throughout the continent, depending on final destination.

APPENDIX

(By kind permission of the author the following testimony to the Subcommittee on Technology, Terrorism and Government Information of the US Senate Judiciary Committee (Feb.26, 2002) is included as an Appendix to the paper that he presented at the Workshop.)

I would like to thank the members of this Committee for their invitation today. I'll begin with an assertion that I think should be made policy:

- **Every container destined to enter or pass through the United States should be treated as a potential weapon of mass destruction; every ship that carries it as a delivery device; and every port and point inland as a potential target.**

While the discussion here today focuses on protecting the port -- natural given the legislation before the committee -- the port, frankly, is the least of the problem.

Yes, it's important to protect the security of the physical infrastructure, yes we have to worry about the safety of specialized vessels and guard against attacks like those which took place on the USS Cole, yes, the technology for sealing and tracking containers is important. But in terms of the system of intermodal international trade – shipping, moving goods around the world in international trade – the port of entry is just one – <u>not even the most important</u> – piece of the puzzle.

If you think about trade as a process of integrated pieces, then **the port should be considered the point of last – not first – resort in our war on trade terrorism.**

To be blunt about it, nothing we have heard discussed today – whether it's electronic seals or port inspections or beefed up patrols or biometric-aided identification cards or GPS or other physical tracking devices on containers or earlier reporting of a ship manifest or neutron scanning 2 percent or 20 percent of all containers going to the United States – whatever -- has more than a small probability of stopping a determined terrorist from slipping a lethal shipment into the mainstream of international commerce and driving it under the Golden Gate Bridge to an end that none of us would like to see.

That's because the action starts well before the port.

So, focusing on stopping a weaponized cargo at the US port is too little, too late: <u>The port is a potential target, not just a gateway</u>. Ports have little interaction with cargoes other than to lift them off or on the ship, to store them, or to serve as a border funnel for customs activities. Their job is in some respects no different than that of a rail yard or similar intermodal exchange node. They are either efficient pass-throughs, propelling cargoes on their way to their final destination – or, they may become bottlenecks, driving some 20 percent of the national economy into the ground.

If we can't allow a weaponized container in a port, neither can we allow it on the ship, the principal means of delivering goods in intercontinental trade to the United States. Ships suspected to carry these weapons – some ships of which today carry the equivalent of 6500 or more containers -- can only be turned back to the point of embarkation – not stopped, searched, and accessed for removal of an 8x8x48 foot 20-ton container while on the high seas.

- **Interdiction of terrorist activities really needs to begin at the beginning – with the shipper and his customer, at both the physical and transactional start of an order.**

While I fully support the measures designed to protect our seaports contained in this legislation, I suggest to this committee **that the first line of defense in the future isn't the traditional physical border the port represents, but a new technology border – a virtual, electronic border – that we need to push back overseas.**

So, when we talk about technology in this hearing, I think we have to talk about **information technology**, first – because THAT is the first line of defense for our ports**.**

The fact of the matter is that we can't inspect every one of the 17,000 containers that end up in the United States on any given day, either here or in the overseas countries and ports in which they originate, without destroying the fabric of our economy. But we CAN create a hierarchical approach combining physical inspection, human trust procedures and a new process of early electronic inspection employing the latest in information technologies.

Why is this electronic border a necessary approach? If I can, let me turn your attention to a couple of slides.

This first slide illustrates a key point: International trade is a tremendously complex business. A typical trade will have as many as 20-25 involved parties – buyers, sellers, inland transporters on both sides of the ocean, ocean and other water carriers, middlemen, financiers, governments and others – and will generate 30-40 documents. Some 6 million containers, many carrying cargoes for multiple owners and valued on average at $60,000 each, entered the US in the year 2000, on ships carrying from 1000-6000 containers each. If we were to add a physical inspection to one of the very large ships carrying these cargoes to the US through the world's hub ports – the Regina Maersk, for example – a single hour's delay per 20-foot container would add from 150 - 250 man-days (roughly 1 _ to 3 man-years of work shifts) to the time it took to offload the 6000 containers riding that one ship.

Literally millions of people and hundreds of thousands of companies worldwide are engaged in the business of moving cargoes internationally. In the US alone, there are an estimated 400,000 importing and exporting companies, 5,000 licensed forwarders and customs brokers, perhaps as many as 40,000 consolidators large and small, and millions engaged in the transportation industry. Worldwide, there are at least in theory some 500 ocean carriers – although probably 10-15 carry 90 percent of cargoes shipped between continents – an estimated 50-70,000 forwarders and tens of thousands more intermediaries, not to mention several million companies moving goods.

This is a process that literally spews data – data on the contents, on who touched the cargo, who paid for it, where it's been, where it's going.

And it's a process into which commercial shippers – the people who own, buy, or sell a cargo – tap into daily, in one form or another, to collaborate on transportation and financial transactions, to exchange documents, to meet regulatory requirements of the various jurisdictions in which they operate, in addition, of course, to documenting the basic buy-sell transaction that begins the shipment.

So, when I look at what technology you need to protect a US port, I look back to the beginning of the process, before the port, before the ship, before the port of embarkation, before even

sealing the container. I look to the buy-sell transaction and the purchase order that is generated from it. Then I look to the manufacturer or supplier overseas, his manufacturing and supplier processes, how and where he or a consolidator somewhere loads the container, when and how it was sealed, how it was moved, who touched it, who paid for it – and even where it might be going once the cargo reaches the United States. <u>For the most part, every bit of that data is available – somewhere and in some form, but not necessarily captured in one place by the private sector, and certainly not by the US government – but there nonetheless, before the cargo ever gets loaded onto a ship bound for a US port</u>.

Throughout this process, the shippers of the goods are for the most part physically out of control of the trade. They've hired freight forwarders or consolidators or third party logistics companies to handle the business because their expertise is in the manufacturing, marketing, and sale of the product. All they really care about at the gross level is that they get exactly what they ordered – no more and no less – and that it gets there at the time and price promised. Some have created intelligent order systems, spent millions of dollars on enterprise resource planning and automated customer service systems, and others have acquired or constructed internally services like those offered by my own company which allow them to track, measure, and steer the progress of their goods through the transportation chain, either physically or in terms of process and paperwork, the latter actually being more important in the manufacturing process than where something actually is. As long as they know it's on course, are apprised of delays, have the ability to re-plan a move or a manufacturing process in the event of a supply chain problem – than they are satisfied. That's really all they need.

The focus of logisticians and companies – particularly American companies – over the last several decades has been on making that flow faster, cheaper, more transparent, and faster yet. Our success at that provides an enormous competitive advantage to many of our companies and makes a huge contribution to the reduction in the cost of numerous articles and products crucial to everyday life in the United States.

Some in the government have suggested that, as in aviation, security rather than speed might provide the competitive edge for ports in the US in the future.

With all due respect, speed and cost were the two most important criteria for the selection of ports and transportation before September 11 – and they will, for all but a handful of shippers – continue to be the most important criteria in the future.

<u>There is a reason for that: Speed equals money. It also happens to equal security, as it leads to fewer opportunities to tamper with a cargo.</u>

Because the manufacturing system knows that, logistics costs have steadily declined from 25 percent to lower than 15 percent of GDP over the last 20 years. Carrying costs associated just with inventory at rest – goods in storage, the response of a manufacturer to uncertainties in the supply chain – in 2000 amounted to nearly $400 billion. A number of experts have estimated that just a five percent addition to the logistics process – thus causing an increase in inventories, the response industry will have to take in order to make up for slow processing times – would cost the economy an additional $75 billion annually. That's the equivalent, by the way, of some 75,000 jobs lost, not counting the multiplier effect of these wholly non-productive costs

Introducing uncertainty, slowing down cargoes through physical inspection of every container and every box inside it, otherwise derailing the transportation system, is exactly the opposite of what we should do if our goal is to maintain a healthy American economy.

So, the most critical piece of the technology solution to guarding our ports, in my mind, is this: Profile cargoes, just as we profile people in the passenger airline industry, before they ever get on the ship – or plane, truck, or train – bound for the United States and its ports.

- <u>The data that the private sector uses to make its processes more efficient is the same data that the United States government needs to understand the commercial processes underlying a cargo profiling process</u>.

The next several slides talk to that process, but in short form, it's pretty straightforward.

In the profiling scheme that I suggested some months back, commercial data would: (1) Be captured prior to loading of a container on a ship, train, plane, or truck in international commerce, from the shipper, consignee, intermediary, banks, and all others that had an interest in or touched or processed the shipment; (2) Combined with certain relevant law enforcement and national security information; and, (3) Be processed through a form of artificial intelligence (including evolutionary computing) to provide a "profile" for every container and shipment within it. The profiling process would generate a "go-no go" decision driving further actions – loading on a carrier, physical inspection, further profiling, etc.

<u>The profile should be based not only on what the cargo was said to be, but where it came from, its likelihood of being what it is stated to be, who handled it from packing through transport to a port, who would be handling it afterwards, where it had been and where it was going, who had a financial interest in it, etc.</u>

- **It's not just about WHAT's in the container, but the CIRCUMSTANCES in which the container finds itself in the trade and transportation process.**

The algorithm used to analyze it should consider not only fact-based data (eg, what the product was and who touched it), but situational data – eg, a container originating in an unstable country and passing by Yankee Stadium on the day and hour the President was scheduled to throw out the first ball.

Based on some probability calculus, the air, ocean, train, or truck carrier could be told that the government either felt the cargo was safe to carry – or – that further investigation, including perhaps a physical inspection, was necessary. (any have raised the issue of the necessity for foreign government cooperation in this process. While it's an important thing to have, perhaps, for political purposes including comity, it's not necessary. As long as the reporting mandates fall on the American importer or his designated agent/intermediary, then the US government has a stick that carries all the way down to the carriers, foreign manufacturers, and foreign transportation players.)

Thus, if a carrier under this scenario loaded the cargo deemed safe and was later told enroute that the cargo might require further investigation, then the carrier – having cooperated with the USG on the pre-release process – should be held harmless from further government sanctions, although it might well have to divert the vessel prior to or on arrival in a US port. (Indemnification here is a form of positive coercion that avoids the extraterritoriality issue.)

If a carrier received notification that a shipment was suspect prior to loading, it should then be required to arrange to have the cargo physically screened, or disclose why not. Screening could be carried out by U.S. Customs officials stationed in overseas points, foreign officials subject to bilaterals and some level of performance auditing, or by the companies themselves, again subject to performance auditing and rigorous procedural standards. The actual inspection could take

several forms, ranging from passively examining the container (neutron/gamma scanning, motion detection, etc), to employing radiological and chemical "sniffers," all the way to breaking the seal and opening it up.

Each of these methods has costs, risks, and probabilities associated with it and should be employed differentially against the perceived calculated risk. Screening might, in many cases, consist merely of re-checking documentation for inconsistencies and communicating with those who provided the documents to clarify the issue. Breaking a seal would, however, require some form of indemnifying the carrier, including possibly an entry order to do so from US Customs. Again, none of these actions have to involve a foreign government. The United States has the authority to deny entry of vessels that it deems of risk to itself, and to deny entry of goods deemed illegal. Providing process incentives to carry out the inspection prior to leading the port or embarkation is a legitimate, effective form of positive coercion. In the end, however, there is no doubt that the support of foreign trading partners and international organizations should be solicited, if only because our leading trading partners are themselves potential targets and will no doubt feel the need for reciprocal protections.

This raises other issues, of course, one being the question of whether or not we would need to place US Customs inspectors inside foreign ports of embarkation. My answer is: Maybe yes, maybe no. US government agencies frequently place inspectors, expeditors, and agents inside the premises of companies in the continental United States, sometimes with and sometimes without the invitation of the private companies involved. Companies often place employees whose job it is to ascertain quality, manage logistics, and to perform other expediting services in the home facilities of suppliers or customers, again at the invitation of the parties. US Customs inspectors could certainly be stationed inside the facilities of major carriers and manufacturers overseas (as they are already), at their invitation, without generating an official response from a foreign government, in order to provide processing capabilities. Carriers and manufacturers that did this – whether by invitation or by USG mandate – could legitimately be considered "trusted parties" and receive "fast lane" treatment on arrival in Customs in the United States, assuming that proper cargo security procedures were employed across the length of the supply chain.

The bottom line, however, is that this is NOT about inspecting the majority of containers or shipments. The goal, in fact, is to use information technology to substantially REDUCE the need to physically inspect containers, to do so at a point in the logistics process that is the least damaging to it economically, and at which diversion of a contaminated cargo can be safely accomplished without delaying other cargoes.

By the way, this is NOT about enforcing US customs compliance rules overseas – something that frequently seems to be mistaken for the prevention of terrorism in many of the proposals placed on the table. This is about determining which shipments and cargoes might be a threat to the United States and its citizens, not about whether or not US tariff rules are complied with. The latter has only a little to do with helping to ascertain the former, which is largely a function designed for revenue capture. Not only are these not the same things, but treating this process as a means of enforcing customs rules could actually undermine the anti-terrorism effort. A legal cargo can become a lethal cargo under the proper circumstances. Thus, treating this as a customs compliance problem not only doesn't solve the problem, it actually has the potential to lull the public and the USG into a dangerously false sense of security.

This may well be one of the most important reasons that the authority for both the collection and processing of the commercial data piece of this process should lie elsewhere, outside of Customs – probably in the TSA or Commerce or some other government agency.

<u>There are three important attributes to this solution and the approach I suggest</u>.

First and foremost, it taps into the existing commercial trade management process and leverages existing relationships into a new holistic structure. Second, it is potentially fully independent of the need for international cooperation, as it requires only the compliance of the US-side of the equation, particularly if process compliance was specifically designated to be the responsibility of the buyer, a suggestion I have made elsewhere. And, finally, it is an approach that makes the greatest use of the technologies being developed by the private sector for use by commercial customers in a normal but obviously complex operating environment.

All of this is easy to suggest, of course, and somewhat more difficult to implement.

But, to give you an idea of where we actually stand, four existing commercial documents already reported in one form or another to Customs and the Coast Guard can provide much – but not all – of the data that would allow us to profile a cargo based on contents, involved parties, and transport mode and path prior to its ever getting on a ship: (1) The Shippers Letter of Instruction; (2) Commercial Invoice; (3) Certificate of Origin; and (4) The carrier's Bill of Lading. <u>To that I would add (5) financial data, perhaps captured through Letters of Credit or bank reporting; (6) Inland transportation leg information not now captured by ocean carriers or the government, on both sides of the supply chain; and perhaps additional information</u>.

On the commercial side, database structures already exist that are designed to integrate data from disparate sources (for example, EDI transmissions, faxes, the web, and email) and that, in computer parlance, allow you to **instantiate a fully attributed shipment**. Why a shipment? Because trade moves in shipments, first, and only then in containers. From the standpoint of profiling, shipment records need to be **fully attributed** – meaning that they need to contain detailed information about the shipment including all of the **parties that are involved** in the transaction, the route/itinerary of the shipment, the items that are contained in the shipment, the events/status of the shipment and its financial terms and any other information that was thought necessary. And, the system needs to be able to collect, process and integrate this data and to provide the required **normalized** data elements to support container and risk profiling in support of Homeland Security.

Collecting and managing the entire set of commercial data isn't rocket science, although not a lot of us do it. But it is what the private sector is beginning to look for today.

Analyzing the data IS rocket science, however. But, again, a variety of the required processes are already in use inside the government and the commercial sectors alike – in everything from looking for illicit drug traffic to screening genetic samples for new drugs for medical purposes.

Without going into a lot of detail, the analytical process should be designed at the simplest level to check against lists – Denied Party Screening, for example; and at the most complex level to think, to learn, and to detect deviations from what we know in our own experience is normal in the operations of international transportation and manufacturing -- anomalies captured in rules and facts which may pertain to both specific and general information, relationships between data, expectations and other expertise. Items that violate expectations or otherwise contradict human expertise are considered to be more suspicious.

But, of course, cargo profiling is only part of the solution. As should be evident from the above description, this is an onion, with numerous layers. At varying stages across the process we have to layer on passive and physical inspection, physical protection of the ports, protection of the cargo integrity from the basic risks of international transport – spoilage, tampering, theft – the ability to interdict specific cargoes, tracking and visibility solutions, many of which we have heard about today -- that allow us to maintain not only the integrity of the cargo but of the transport system itself once a cargo is in motion.

Cargo profiling is an approach and a system that I believe that the Transportation Security Administration at the US Department of Transportation already has the authority to implement – a question separate from whether or not they have the dollars to do so. (I would note that profiling would certainly cost far less and take less time to implement than a full system of inspections, electronic seals, etc.) TSA needs the support, almost in a sub-contracting role, of the US Customs Service, the US Coast Guard, the various modal agencies, and, perhaps the US Department of Commerce alike. The data base process could perhaps ultimately be embedded into and as an extension of the Automated Customs Enforcement (ACE) system that Customs is currently building – but which will take another three-five years to deliver. This is NOT a solution that I would recommend, however. Given the cooperation necessary from the private sector even under a new mandatory reporting regime, Customs – the "bad guy" to even "good guys" in the international trading arena -- isn't the best place to locate this kind of effort for the maximum impact, despite their current role and skill in the import transaction. The US Coast Guard and other national security and defense agencies also have extensive law enforcement and national security data base efforts going on, and numerous government data bases could be tapped through the new process for relevant data without violating the need to maintain the competitive position of individual companies and due process for the parties involved.

<u>I don't believe, however, that we should or need to wait that long to implement a robust, commercially relevant, profiling solution</u>. We should be looking – today -- at other USG data bases, including the so-called ITDS system being developed several years ago at Treasury, outside of Customs, as a possible stopgap; and, we should be looking to the private sector as well for information technology accelerators. There may well be other data efforts underway elsewhere in the law enforcement and national security community that present relevant opportunities, as well. Several groups of commercial and governmental players have also suggested demonstration projects that would cover ports and inland movements on both sides of the traffic on both the East and West Coasts, as well as on our northern and southern borders, using commercially available information technologies and real-world data and cargo movements.

As a general comment here, I believe strongly that a critical issue here will be to obtain voluntary – not just mandatory – commercial compliance with all of the parties in the commercial transaction. Many of the processes covered here are outside the domain of US law enforcement. We can't today make foreign suppliers abide by all of these rules, but we can certainly tell their US customers – today -- that they may face delays unless they know their sources and can validate cargo and process integrity. We can't today tell a foreign port that it has to purchase millions of dollars worth of screening devices for the cargoes destined for the US which our screening picks out as suspect, but we can – today -- certainly negotiate procedural agreements through the IMO and individual American ports and distribution arms can provide speed incentives for those that work with us. The ocean carriers barely make 1-2 percent ROI, so they

will only be driven into bankruptcy if we require that they purchase screening machines and add hundreds of new security personnel, but we may be able to help them through the imposition of a user charge on all cargoes going through US ports, a portion of which is used to offset their additional costs. We can't today mandate that the carriers for which the US is only one of several stops profile all of their cargoes before sailing; but we can no doubt – today -- find a way to say that if we determine that a cargo is found to be suspect the entire ship will be turned back because we won't risk the US port.

In closing, I'd like to reiterate the point with which I began: US ports aren't the first line of defense but almost the last.

This Committee and this government have a real obligation to see that no weaponized container ever makes it to the port, period. They have an obligation to protect the integrity of cargoes once entered, and they have an obligation to their customers – the failure of which to provide will destroy their commercial viability and that of the general economy – to provide a speedy, low-cost transportation move. I believe we have the technical means to tap into the commercial process, to profile shipments and containers, and thus, in concert with other actions, to see that no container intended to be used as a terrorist device ever gets on a ship, a plane, a truck or a train bound for the United States. We have the technology to do it, but the process starts well before a container ever reaches a port.

Members of this Committee: When the aviation system went down on September 11, we already had a security system, as imperfect as it was, in place, which could be re-booted three days later at a higher state of readiness.

However -- If a container blew at a port or somewhere else in the international transportation chain ending in the United States, this nation and its leaders would have no choice but to shut down the entire system of trade with our country. We have no security system in place in our international trade system comparable to that which pre-existed in passenger airline travel that we can re-boot. We have nothing at all in place to properly secure over $2 trillion in trade and the millions of American jobs associated with it. Electronic seals, tracking, additional port security – none of that will solve that problem adequately. We DO have the technology available to begin to profile shipments aimed at the United States, today. It's not the complete solution, but it's an appropriate start.

Again, I appreciate the Committee's time, and would be glad to discuss it further.

Joint Military/Civilian Incident Command Systems for Homeland Defense

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I would like to start out with a movie to get your attention. It's always good to have an appeal to authority to start you off, and so we have a bit of a movie from last March when we were fortunate to have the President look at part of our technology demonstration.

Movie clip of President Bush: I have just seen a demonstration that helps prepare the emergency firefighters and police for how to take care of a disaster or an attack… how best to protect the citizens. And, I want to thank all those involved with the Center for Emergency Response Technology Instruction and Policy for their hospitality and for the chance to see… first hand how Atlanta and the State of Georgia are preparing for any possible attack. I particularly want to thank the guy who they cut off his clothes and ran him through the water. That goes beyond the call of duty to impress the President. There he is… better you than me.

OK, thank you. Well, that was an exercise we did with some of our technology. It was actually the second major exercise we have done dealing with chemical, biological, nuclear, and radiological attacks. We started about three or four years ago, when I came to Georgia Tech and they asked me to start working on weapons of mass destruction. I decided that wasn't a good idea to put in the title of my center, so it's the Center for Emergency Response and so on.

Now, why Atlanta? Well first of all, after the Olympic Games the first responders, including the military first responders, in the community saw all of the shortfalls because of the planning they had to do for the 1996 Olympics. Second, we were fortunate to have some leadership in the form of our two Senators from Georgia, one Republican and one Democrat, who ran a series of seminars starting back in 1996 warning of the dangers of terrorism and weapons of mass destruction. So, the people were somewhat sensitized by that. Another reason is that Atlanta has been attacked. Atlanta is a lucrative terrorist target, I guess you'd say. Going back to the 1950s with bombing of the synagogue which happens to be three blocks from my house. So the bad news is that we're a target. The good news, however, is that there are a lot of good technology, medical, and other folks in that region that can help deal with the problem. So we wanted to harness that expertise.

From a personal point of view, I spent 24 years here in Washington being a contractor. I went to the Ukraine for two years living in fear of my life most of the time because the Ukrainian Mafia has a tendency to run over people that they don't like with large trucks. When I came back home to Atlanta and I thought that everything's fine… I can walk the streets, no problem. Then someone delivered an anthrax letter bomb to the hotel two blocks up the street from me…and I said you know it's a classic tale, when you come home there are still problems that you have to take care of. So, that started my personal commitment. The first thing I did was to go out and

start talking to the regional people in the area, from the local level on up through to the federal level, to try to get them together to understand what the problems were here and to get their buy in to what we we're doing.

Along the way we went to a war game hosted by the Marine Corps Warfighting Laboratory (MCWL) which is across the circle over here. What we concluded from that was that we weren't sure what the federal response of a terrorist attack would be and we certainly weren't sure what the state response would be, but we knew that first responders were going to be on the line. So, that's where we decided to start… from the bottom up. Another part of the other reason for that was the CETO (Center for Emerging Threats and Opportunities) unit of the Marine Corps, which is essentially a first responder unit.

So, what do we do? Well we develop technologies, we try to assert them, we try to find affordable technologies that can be useful because we're still down at the local level and they don't have a whole lot of bucks… so whatever we do has to be affordable. The military likes affordable technologies because they can throw them away and feel happy about it… so affordability is one of our criteria.

For about 15 years, Georgia Tech as part of its state mission has trained HAZMAT incident response people with its 'chem-bio' courses. We have about 8,000 graduates of that program… so we have pretty good roots since we've trained all those folks out in the first responder community. In addition to commercial and state government folks, we now also provide a lot of fire training, and some military training as well. Also, we formed a group of not-for-profits and universities to work with us. For example, Midwest Research provides chemical agents such as anthrax and sarin, and what not… we don't have any on campus of course, so they do our testing and some of our work for us. The University of South Carolina works with us. They have developed software that supports state emergency operations centers. And, Battelle (Stafford) who are mainly in charge with supporting the CBIRF unit of the Marine Corps..

Our funding really started out with BGen Donovan of the Marine Corps Warfighting Laboratory (MCWL), who had the foresight to see importance of our efforts and gave us $2 million dollars to get started. About two years ago we were reeling under deadlines from that effort and I'll show you some results from their demonstration in November two years ago. That effort has now been transferred to the Marine Corps Systems Command as our technologies mature. This is one of the last war charts (Slide 2), I promise that I will try to keep you awake with some pictures… go to the next one please.

We received some funding from the Marine Corps Warfighting Laboratory (MCWL) in May 2000 and we put on a demonstration in November 2000, using some of these technologies. It was a chemical spill. We don't have any nerve agents on campus but that was the scenario. It was called in to the Atlanta Fire Department, so the Atlanta Fire Department responded… the state responded… the city responded… and oh, by the way CBIRF happened to be in town and had 50 people who also worked as part of the exercise. We had subjects that were trained by a doctor to show signs of nerve agent poisoning, mainly for our marketing department… they seem to like that sort of thing… but you can see we had both non-ambulatory and ambulatory patients. It was an Urban Search and Rescue situation where the responders (Firefighters and CBIRF personnel) had to go in and rescue people from this building, which happens to be my building.

Now, the first thing that the first responders said they needed were better communications. The model I had for coordinating the response operations was Incident Command. I guess some

people don't know what incident command is? Incident command occurs when you have an incident such as a chemical or biological release or radiological release, and the first guy on the scene is usually the fire chief in charge of that locality. He becomes the incident commander. Incident command is the official doctrine of the United States in terms of these types of events, but the doctrine really originated with the fire and HAZMAT folks. So, my motto for what happens in these cases is that the incident commander is the fire chief who is in charge, and he has resources from a lot of different places including the military.

We have vivid footage of a real incident at an Air Force Reserve Base north of Atlanta. The incident commander was literally strapped with cell phones and radios to be interoperable with all these different units that he's in control of. We said, we should be able to do a little bit better than that… we can get better and more reliable communications. So we did two things. First, we provided military style organic digital communications at the site so that we can get from the incident command post into the hot zone… and we've made some considerable efforts to make the things we're using operable in the hot zone. Now, any first responder who's on site and who has a Palm Pilot with a suitable card in it, or a laptop, or wearable computer, can share information around the site.

The second thing we did was to provide the incident commander with a connection into the Internet… representative of a wide area network. Now we have connectivity from the hot zone to literally anywhere in the world. We tried to exercise this capability in some of our demonstrations. In one particular case we did a medical emergency. We called it a medical reach-back experiment… to try to stretch the bandwidth of that system. We did the reach-back experiment to not only our local emergency hospital which is about six miles away (Grady Hospital), but also to the Army Edgewood Medical Treatment facility where there is one of the few doctors in the world who has actually treated chemical agent casualties.

So in our medical reach-back experiment (Slide 6) you can see a Marine who is collecting data for each patient. The philosophy is, each patient gets his own web-page. When he shows up he gets a bracelet with a bar code on it. We can scan that with a Palm Pilot. That trundles off to start the web page, and now we load the web page with medical data so that doctors can look at it. One important reason we do this is that in Georgia, as in other states, emergency medical personnel cannot administer antidotes for anything without a doctor's permission. If there's no doctor in the hot zone then the patient is unlikely to survive even if you get him to the hospital, because it's a matter of minutes for some nerve agent exposures… so we need a virtual doctor out there.

We went around the world looking for FDA approved field gear that we could use. We found instruments to take blood pressure, EKGs, blood type, pulse, and so on. None of those things really exist in one package. However, there are some signs that the military wants to bundle them together. The idea is that all of that data trundles off to the web-page… our Marine is entering the symptoms of the patient and other data through his Palm Pilot, and that also goes off to the web-page. In our demonstration in November 2000 and also in March 2001 with the President, we authorized treatment based on that data with doctors looking at the data and holding telephone conversations.

Now the other thing that we found was that the first responders, including the military, said well we've been off to 'chem-bio' school and we had it drummed into us several times about this agent and that agent, and about this symptom and that symptom, but we forget it all when we went back home. So, during the Olympics they took an 8.5in x 11in sheet of paper and they put

all of the symptoms they could find in their textbook down one side and all of the agents they could find on the other, and they laminated it, put a grease pencil on it, and that was put in every fire engine in the city. Of course, there were a few problems with that. For one, it doesn't have medical validity because of the time course of exposure and all that kind of stuff. So we said to ourselves, we can do something that's a little bit better than that. We provided what we call a decision aid. When the Marine enters the symptoms into the Palm Pilot, it comes back and gives the probability of what that person's been exposed to.

Now we've also… in the other direction… joined these scenarios. We have what we call a building viewer. When the fireman goes into the building, can we give him information he can use? We load the building plans down through the Internet onto his Palm Pilot so that when he goes in he has some idea of what the building looks like. We get those plans from the Fire Department, which of course has to keep those kinds of records… not all digitized yet… but coming along. Also, we can send him instructions on decontamination… he can get e-mail, and so on. You can actually surf the Internet with your Palm Pilot and get whatever you need… material data, handling sheets, whatever you need to help yourself. So we're tackling the problem from both directions and we found that this works pretty well.

The next thing that the first responders said was that they needed sensors that would tell them what they are dealing with. For example, is it a chemical or biological agent? We needed something cheap. We can't afford the military sensors, and we don't necessarily want to learn how to use a mass-spectrometer that costs about $90,000 and takes a person with a Ph.D. to operate. So, we went to the environmental and food processing industries to look for sensor technology. The technology that they came up with is a sensor that's about 4 cubic inches in size and promises to get even smaller. It can sense closed vapor and in vapor phase and in aqueous phase. The device consists of a glass slide that's etched using microelectronics and a laser light source. It's the same laser that's in your CD-ROM player and costs about $12. We put a chemically sensitive coating on that slide and we use an interferometer which compares the area under the chemical coating with a control area. It is very, very sensitive in terms of detection. This device can detect in a 0.5in by 1in slide configuration about 75 different things, with concentration readings.

We now have a sensor that costs a couple hundred dollars that we can put all around the city. But to keep track and make sense of these sensors we need some kind of geographic underlay. For those of you who don't recognize it, this is the Atlanta skyline (Slide 10), and this is part of a virtual GIS (Geographic Information System) that we have (Slide 11). From the Olympics effort we have this pretty good database for Atlanta and other places that we can use as an underlay. We're working on having it in 3D and we're working on the capability of being able to click on a window and obtain information about the people are who live there and so forth in terms of anything that's geographically referenced. Currently, we can tell you how many schools, how many people, where they're all located within each one of those contours. And the philosophy is that the fire chief shouldn't have to plot the plumes. That could all be done at the state command center or county command center. Since he's on the Internet all he has to do is go to the right web-page and pull up those projections from his laptop.

After September 11 they said, you've done so well helping first responders why don't you try to broaden what you're doing at Georgia Tech to other places and other missions. Consequently, we have been acquiring additional technologies that are now in the mix for the military and the civilian communities. So in closing, what we've tried to do is to start from the bottom up to

develop technology, insert it and get some feedback from the users, to help them deal with these incidents, which may involve a host of civilian agencies, as well as some military agencies. We're also headed back into things like federal databases. How do we get them down to the fire chief? We just did a medical experiment in one of our demonstrations because that was the easiest path. It's harder to do a law enforcement scenario, or a decontamination scenario where you need chemists around the country to help you. Hopefully, those things will become more possible in the future.

Georgia Tech Homeland Defense Initiative: Joint Civilian Military Incident Command

GEORGIA TECH
Homeland Defense Initiative

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Georgia Institute of Technology

Slide 1

What is CERTIP?

GEORGIA TECH
Homeland Defense Initiative

- Center at Georgia Tech to Lead Grass-Roots Response to Risks Associated with Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) Agents
- Founded in 1999
- Hub of Regional Partnership of Over 50 Organizations Involved With CBRNE Emergency Response
- Projects to Develop Technology for Military and Civilian First Responders
- Provides Engineering/Science Expertise to CBRNE Incidents
- Hazmat and CB Training for Civilian and Military
- Initiates National University and Not-for-profit Partnerships to Conduct Research and Development on New Technologies
  - Midwest Research Institute (MO and FL) -University of South Carolina
  - Battelle (Stafford, VA)
- Funding Partner is US Marine Corps MARCORSYSCOM
  - Supporting Technologies for USMC CBIRF

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Slide 2

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Project Atlanta (Nov 2000)

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Slide 3

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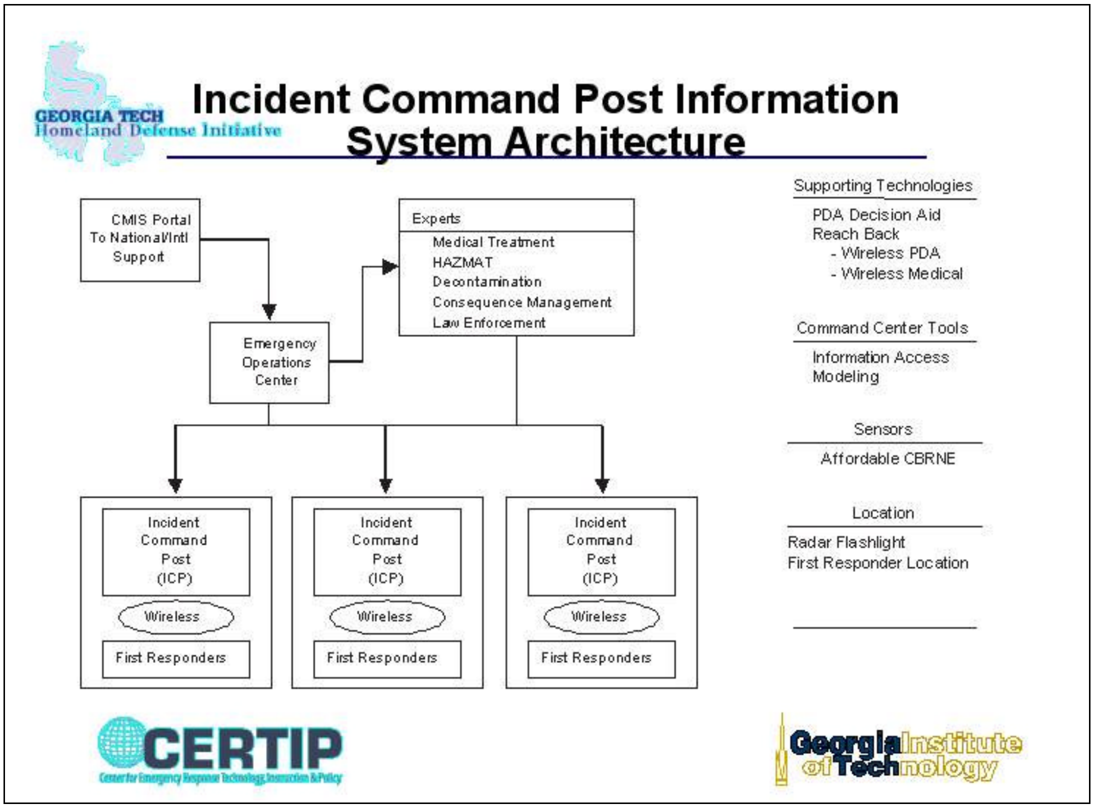
Slide 4



Slide 5

Slide 6

PDA Communications and Decision Aid

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Slide 7

Chem-Bio Sensor

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Slide 8

Integrated Optic Sensor for Chemical and Biological Detection

GEORGIA TECH Homeland Defense Initiative

IO Sensor Advantages

- Small low-power package
- Reversible or integrating sensing mechanisms
- Sub-second to minutes response time
- Novel and unique chemical amplifications
- Enhanced selectivity through molecular recognition
- Multiple analyte detection on a single chip
- Performance independent of wavelength and optical power
- Nulling of thermal and mechanical noise

Limits of Detection

Vapor Phase:	
BTEX	<1 ppmv
Chlorinated Hydrocarbons	10 ppmv
Ammonia	<100 ppbv
Aqueous Phase:	
BTEX	<50 ppb
Chlorinated Hydrocarbons	<100 ppb
pH	0-14
Ammonia	<100 ppb
Proteins	<1 ng/ml

Sensor Applications

- Air quality
- Water quality
- Process control
- Food safety
- Biomedical assays
- Chem/Bio weapons

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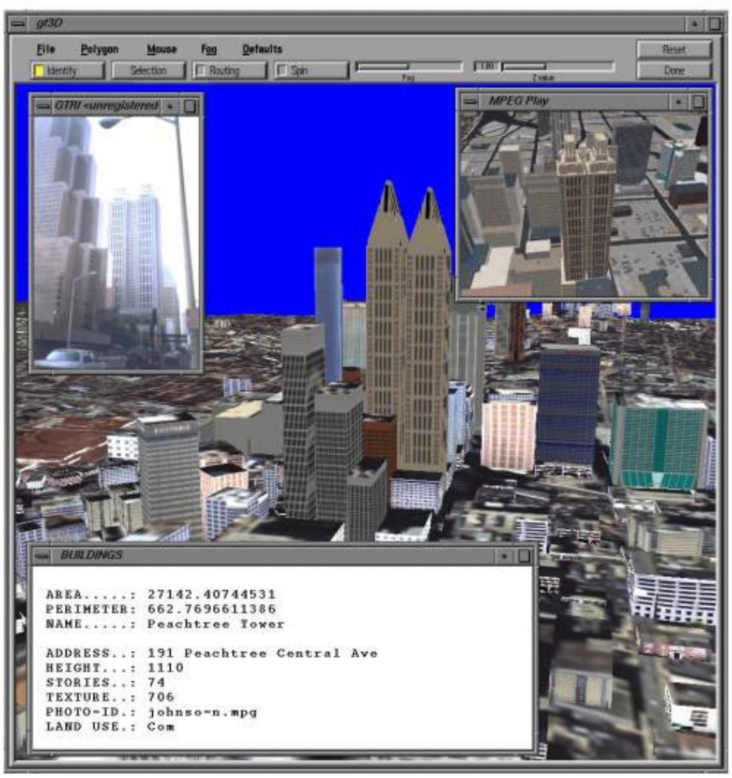
Slide 9



Slide 10

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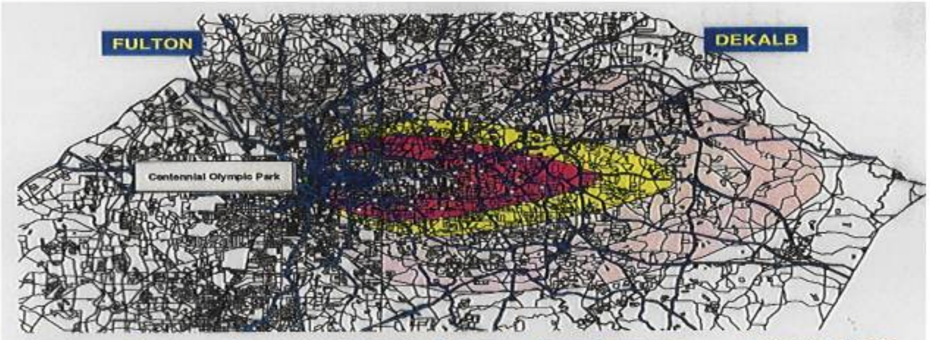
Hazardous Materials Airborne Release Simulation



Minutes	Blocks	Population Affected	Schools	Total Enrolment	Hospitals	Beds
15	172	7978	2	750	1	430
30	635	36893	7	3442	2	502
45	1193	74718	24	11196	6	2260
60	1702	111536	36	19070	9	2620
75	2438	183755	53	33677	14	4085
90	3585	311833	76	51672	16	4506
105	4464	424605	108	71523	18	4778

Sources: 1990 Census Block Data (STF 1B) and 1994 ARC Atlanta Metropolitan Region Data

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of Technology

Slide 11

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Radar Flashlight

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Slide 12

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Homeland Defense Initiative

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Slide 13

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GT-HDI Objectives

- Objective 1: Maximize the contributions of Georgia Tech to the defense of the United States Homeland.
- Objective 2: Obtain funding for research, technology and systems engineering projects.

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Slide 14

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GT Can Contribute to Homeland Security

- Airport/Closed Space Security
  - IT for Terrorist Prediction
  - Physical Security and Package Inspection
  - Biometrics and Lie Detection
  - Tracking Suspicious Persons
- Port Security (Containers)
- IT, Bioinformatics to Detect and Characterize Bioterrorism Attacks
- IT, Communications for Emergency Response
- Human Factors for C4I Centers
- CBRNE Sensors, Urban UAV
- Transportation Security
- Critical Infrastructure Protection
- SOF Support
  - Fuel Cells, Batteries
  - Psy Ops
  - Force Protection
- Terrorism Risk Reduction Methods for Insurance
- Face Recognition Algorithms
- Protection of Buildings from Explosions and Missiles
- Robotics for Emergency Response
- Intelligence Methods

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Slide 15

GEORGIA TECH
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Current Top 15 Thrusts

- GT National Laboratory for Homeland Security*
- Hartsfield Partnership for Airport Security*
- Port of Savannah Partnership
- CERTIP First Responder Technology 03*
- Transportation Security Center 03
- SETA Support to State of Georgia and Federal Region IV (GEMA, ONP, FEMA, EPA, DOT)*
- Technical Support Working Group 03
- Fire Science Materials 03
- Knowledge Management for Intelligence
- CSAGE Agroterrorism Countermeasure Center with UGA
- National Guard Bureau Technology Partnership
- Systems Engineering for C2*
- GT Information Security Center
- Defense Threat Reduction Agency
- Southeast Center for Emerging Biological Threats

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Slide 16

Section C: Information-Centric Technology

The Role of Discovery in Context-Building Decision-Support Systems

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Introduction

There are many sources of on-line information available to those responsible for making decisions in complex situations. However, most of that information is either intended for human use or is available only in custom or proprietary formats. Both of these conditions reduce the ability of computer software to perform automatic reasoning about this information. As a result, the usefulness of on-line information in intelligent decision-support systems is currently limited to the few sources that are implemented specifically for those systems. The vast mass of sources that do not fit that description are virtually invisible.

Current practices for integrating multiple information sources have proven too costly to implement and have produced inflexible systems. These practices, which are discussed further below, cannot cope with the magnitude or the diversity of the available information.

This paper describes the TEGRID project, which demonstrates the use of a *service oriented architecture* to enable a more flexible, loosely coupled system of interoperable information sources and consumers.

Disaster Management Requires Information from Diverse Sources

To determine how best to manage disaster or emergency response, the decision-maker requires access to information from many sources. These sources might include law enforcement agencies, hospitals, ambulance services, the weather service, city traffic control, the National Guard, and so on. Each of these sources is controlled by different organizations, some non-governmental, some local, some state, and some federal; some organizations are civilian, some military. A decision-support system that assists users in planning responses to ongoing emergencies must incorporate information from as many of these sources as possible.

One often-used approach to the problem of inter-system communication is to create an interface agreement (i.e., an exact definition of the format that will be used to communicate data and information). Each system then creates a translation between its own internal data or information model and the format defined by the interface agreement. While this approach is conceptually simple, it poses problems at both the technical and the cultural levels.

It can be very difficult for multiple organizations to reach agreement on an interface format. Such agreements take time and a great deal of focused effort. At the same time, it can be difficult to arrive at common understandings of the information represented by each system. A single model representing all the kinds of information available in all systems may be so extensive that it becomes impractical to implement.

By far the most problematic aspect of the interface agreement approach is its lack of flexibility and extensibility. When any of the systems changes its internal model, this change may make the interface agreement obsolete. In that case, the agreement would have to be renegotiated and modifications would need to be made to all systems, with associated funding requirements. The level of effort required to change an interface once it has been implemented across multiple systems tends to create distributed systems that are brittle, static, and resistant to evolving quickly to meet the changing needs of their users.

Current approaches to inter-system communication too often result in tightly coupled systems. In extreme cases, the coupling becomes so tight that nothing can be changed in any individual system without requiring equivalent changes in other systems. Over time, the coupling of such systems tends to become tighter as more software is written based on assumptions about the exact format of communicated data and information.

Adding more information sources to such a system can also be difficult. As each new system is added, the communication among systems tends to become more complex. Each new revision of the interface agreement becomes more difficult to define, since any changes to the interface require changes to larger sections of the software. The result is a further slowing of growth and change.

This gradual reduction in the amount of change possible in a given period of time is especially injurious to decision-support systems. Decision-support systems, especially in the area of emergency management, should be implemented in a timely manner in order to provide assistance to their users as soon as possible. Furthermore, when users identify a requirement for change to the system, it must be feasible for developers to implement that change quickly so that new functionality is available when the decision-maker needs it.

These requirements, and the problems of the interface agreement approach, led us to consider a different type of architecture for our demonstration system. That architecture must provide (at least) two benefits over architectures that require tightly-coupled communications: first, the architecture must support the rapid addition of new sources of information; and second, the architecture must allow individual information sources to change their communication format while requiring little or no reworking of the systems consuming this information.

The proposed solution involves the loose coupling provided by *web services*, combined with the self-describing information model of the *semantic web*. Both of these concepts are discussed further in the following section.

Service-Oriented Architectures and Web Services

For our demonstration system, we explored the feasibility of replacing the tight coupling of earlier distributed systems with a more loosely-coupled architecture. We implemented a system based on web service standards that allowed us to use a discovery process to construct the system at run-time based on the information needs of the clients. The use of discovery enables each participant in the system to build an awareness of the context in which it is operating. This section defines these concepts, starting with the most basic: the service-oriented architecture.

In a Service-Oriented Architecture (SOA), each information source is considered to be a separate service, providing information to remote clients. Each service is developed and deployed by the

organization that provides the information, eliminating the need for complex interface agreements. Also, each service is remotely accessible, usually over the Internet. Services are generally not constrained to work with a single distributed system. This helps to keep the degree of coupling low, and allows the same service to be used in multiple contexts.

Web Services are a specialization of the more general Service-Oriented Architecture. The definition of Web Service has been hard to pin down, but the World Wide Web Consortium (W3C) has provided the following definition: "A Web service is a software application identified by a URI, whose interfaces and bindings are capable of being defined, described, and discovered as XML artifacts. A Web service supports direct interactions with other software agents using XML-based messages exchanged via Internet-based protocols." (see web site at: (http://www.w3.org/TR/wsa-reqs#IDAIO2IB)) Current implementations of web service standards specialize this farther: most web services use HTTP (Hyper-Text Transfer Protocol) to exchange messages defined in SOAP (Service Oriented Architecture Protocol). The SOAP standard defines an XML language and a set of rules for serializing and de-serializing objects and data, regardless of programming language, operating system, or hardware platform.

The description of web services is handled by WSDL (the Web Services Description Language), while discovery is provided by UDDI (Universal Description, Discovery, and Integration). UDDI defines an XML language for accessing a repository to register and locate web services according to the attributes of the service. The repository may be one of the public registries operated by Microsoft, IBM, or SAP. However, for most uses it is likely that participants will use a community registry accessible only to authorized partners. This paper discusses some of the limitations of WSDL and UDDI, below.

Why Discovery Matters in a Decision-Support System

As discussed earlier, in order to provide the broadest possible support for human decision-making, a decision-support system needs to provide all the information that is: (a) currently available; and, (b) currently relevant. This generally requires bringing together information from multiple sources.

Existing decision-support systems generally require that all potential sources of information be identified when the system is being designed and implemented. This requirement stems from the need to build concrete knowledge about each information source into the decision-support system. The information may include the location of the source, its access protocol, the data or information format, and the type of security used, among others.

The requirement that all sources of information be known prior to deployment prevents the decision-support system from taking advantage of information whose source is not identified (and may not even exist) while the system is being built. Most significantly, this requirement prevents the system from solving the 'transient need' problem. This problem arises when an unexpected situation requires a kind of information that is not present among the sources known to the system. For example, the information may be useful to a decision maker for a short period of time, but irrelevant after that point. Systems that can only use information sources that are known to the designers of the system tend to lack the flexibility required to deal with changes to the information environment and to the needs of the decision-maker.

A system built around web services solves the ‘unknown information source’ problem by adding the ability to discover services at run-time. If the service consumer can understand that a particular service provides information that the consumer can use, in a form that the consumer can process, then the consumer can use information from a previously-unknown source.

Some Limitations of Current Web Service Standards for Discovery

There are two important gaps in the ability of standard web services to discover and use unknown services. First, the standard discovery protocol only allows consumers to search for very specific types of services. In many cases, this amounts to a key-word search, which may result in missed opportunities and mistaken connections. Second, the standard method of defining service operations and parameters limits a would-be consumer to those services that implement operations using the names and classes that the consumer expects.

The difficulty is that the current web service standard for defining services and operations (Web Service Definition Language, or WSDL) does not include any information about the intent and meaning of an operation or its parameters. The best that a client can do is to search for operations based on the model that a given service implements, where the models are publicly defined either by the consumer, the providers, or by an industry standards body. The client will miss services that provide the same functionality but use different models.

For example: in the TEGRID demonstration project, we have created a definition of the operations and parameters for a ‘publish-and-subscribe’ service that allows clients to ask for information to be sent to them on topics of interest, and to send information regarding those topics. This service definition is then placed in the TEGRID service registry as a model of a service that the designers of publish-and-subscribe services may examine and implement. The SubscriptionManager service is one such service. In a real service-oriented system, there might be several services implementing the same model. Information about the SubscriptionManager is then entered into the service registry, including the fact that the SubscriptionManager implements the publish-and-subscribe model.

Participants in the TEGRID system that are interested in either sending or receiving information must implement the consumer side of the publish-and-subscribe model. That is, these participants must be able to discover those services that adhere to this specific model. In other words, they must be able to invoke operations using exact names and constructing parameters using class definitions that must be built-in to the client. Finally, the consumer must be able to receive values of a given class and map those values to objects within the consumer's own information model.

If another service were to provide the same functionality, but used different operation names and different classes for the input and output values, consumers searching the registry for publish-and-subscribe services would miss this equivalent service completely. The problem is that the registry does not describe the *purpose* (or *intent*) of a publish-and-subscribe service. As a result, consumers cannot find services based on a description of their own requirements, but only based on keywords and model definitions. The same problem also prevents consumers from locating new kinds of services (i.e., consumers are unable to describe their functional needs in a way that allows the registry to match those needs to specific service providers).

In short, using current web service standards, the ‘discovery’ process is limited in practical terms to discovering service locations. Adding entirely new types of services after deployment is only possible in limited circumstances. This in turn limits the ability of the client to draw information from all available relevant sources, and moves the effort of defining usable service types back from post-deployment to the development phase. Web service standards increase the flexibility of distributed systems, but they do not take us as far in that direction as we would like.

These limitations do not mean that web services as they are defined today provide no value. Many useful systems can be, will be, and are being built based on current standards. Service models are being defined by consortiums and standards bodies for specific vertical markets. These models will enable wide-spread interoperability. Service producers and consumers written for those models have the potential to provide unprecedented levels of system-to-system communication throughout an industry, resulting in significant increases in productivity.

Additionally, WSDL (the language used for defining service models) is designed to enable automated generation of client and server interfaces. The effort of incorporating a new service model defined in WSDL into a consumer is therefore generally very small, so that modifying a consumer to access a new type of information server can be done quickly and at little cost. Many (perhaps most) web service consumers will never have a need to dynamically locate sources of entirely unknown kinds of information. For these consumers, the limitations of the current methods of locating web services are simply irrelevant.

In order to provide full support for decision makers in areas where time is critical, on the other hand, these limitations do matter. The goal is to be able to give decision makers access to the information they need, when they need it, even when this involves types of information that were not anticipated by the designers of the system. At the CADRC, we are engaged in ongoing research exploring the use of semantic information to extend web services. We hope that such an approach will eventually allow systems to become progressively more flexible and responsive to the needs of their users. Some background on and explanation of the semantic approach is given in the next section.

Semantic Web Services

Several years ago, Tim Berners-Lee (the originator of the World Wide Web) began to discuss his vision of the future of the web. The web as it currently exists consists mainly of human-readable information. The markup in web pages is dedicated almost entirely to presentation instructions. This means that the only machine-processable content of most web pages is concerned with how the page should look.

Berners-Lee envisioned a web whose contents would include a new kind of markup that would enable software to reason about the *meaning* of the contents of a page. This would enable very intelligent automated processing of information on the web. Essentially, it would turn the contents of the web into an enormous knowledge base. Berners-Lee calls this vision of the future the *Semantic Web*. Semantic and logic languages are being developed to support this vision. The most influential of these languages is called RDF (Resource Definition Framework). RDF is deceptively simple, but has very deep underpinnings in the constructs and theory of formal logic.

Another language related to the Semantic Web is DAML-OIL (DARPA Agent Markup Language – Ontology Inference Layer). DAML-OIL builds on RDF, adding more complex

object-oriented concepts. DAML-OIL was submitted to the World Wide Web Consortium's Semantic Web working group, as the basis for the standardized OWL language, which is currently under development. It is likely that when OWL emerges from committee, it will bear a strong resemblance to DAML-OIL, although there may be significant differences.

Although web services and the semantic web are being defined by two very different communities, there is a growing realization of the potential synergy between the two. The basic idea here is that web services are a powerful means to deliver semantic information, while enhancing web service standards with semantic information will increase their flexibility and their effectiveness. The combination of Web Services with the Semantic Web is referred to (not surprisingly) as *Semantic Web Services*.

How Does Semantic Information Improve Service Discovery?

As discussed above, the current methods of discovering and invoking services and operations do not deal with the meaning of either the operations themselves or the classes of the parameters and return values (the input to and output from the operations). This limitation can be described succinctly as the *lack of semantic information*.

The premise of the research project currently in progress at the CADRC is as follows: If service definitions were to be expanded to include a formal description of the purpose of each operation, as well as an ontology that relates the classes of objects being passed in and out to other classes and concepts in the domain of knowledge, it would become possible for a would-be consumer to make a more intelligent determination of the suitability of a given operation to the consumer’s own needs.

Semantic information concerning the service's domain of knowledge may also allow the prospective consumer to map operation parameters and return values to the consumer's own representation. This mapping is critical to the possibility of accessing services with unknown operation models. In other words, the consumer needs to be able to determine what information must be sent each operation, and what to do with the information received from the service. Without the ability to create mappings to and from its own information model at run-time, a consumer is again restricted to exactly those services that implement a service model that is built into the consumer during design and development.

In a previous pilot project, CADRC developers defined several ontologies using DAML (DARPA Agent Markup Language) and demonstrated the ability of a client program to automatically merge ontologies from multiple services under controlled conditions. This demonstration project also showed that users could extend the information model of a program at execution time, and that inference rules written for a specific ontology could also operate on instances of classes that the client had received from service provider, even though the classes were not known to the developers that wrote the rules. A future project will extend this investigation to include DAML-S (DAML Services), a vocabulary with semantics for defining the capabilities of services. We hope to learn whether the use of DAML-S to define the semantics of a service can enable a consumer to discover and utilize services without the need for each service to implement a specific interface.

The goal of adding semantic-level service descriptions is to enable consumers to locate services based on each service's purpose, rather than the names of the service's operations or the types of its parameters. This description of purpose is stated in a formal language that can be interpreted by the client. Automated reasoning can then determine the relationships between each operation and the definition of services needed by the client. Semantic description will allow service discovery to become more flexible, and will eventually lead to systems that can evolve as more services become available and the needs of the users of client program change over time.

The TEGRID Demonstration System

To demonstrate the use of web services and discovery in a decision-support system, the CADRC implemented a system within the context of emergency management of the rolling power outages experienced in many parts of California during the summer of 2001. This system is called TEGRID (i.e., 'Taming the Electric Grid').

Based on knowledge acquisition performed under the auspices of the National Institute for Urban Search and Rescue (NIUSR), and with the cooperation of the Los Angeles Sheriff's Department in the Fall of 2001, we identified several distinct entities that would be involved in planning and executing responses to power outage situations. Among these: the local sheriff stations (LSS); rapid response teams (RRT); the power supply organization (PSO); the traffic control organization (TCO); and the emergency operations bureau (EOB). The remainder of this section describes the responsibilities and actions of each of these major participants in the TEGRID demonstration system.

In the demonstration scenario, the Emergency Operations Bureau (EOB) is responsible for coordinating responses to the announcement of power outages. This coordination potentially includes a wide variety of decisions and communications. For the purposes of the scenario, we implemented only the assignment of Rapid Response Teams to provide support for local sheriff stations at priority locations.

Since the focus of this demonstration was on constructing the system through discovery and loosely-coupled communication through web services, we simulated the existence of several information sources:

1. A database at each local sheriff station that contains current officer assignments, equipment manifests and status, and priority infrastructure and intersections.

2. Lists of Rapid Response Teams (RRTs) and their primary and alternative assignments, maintained by the Emergency Operations Bureau (EOB).

3. Current power supply information, along with alerts about planned and current power outages, maintained and disseminated by a Power Supply Organization (PSO).

4. Traffic information, especially alternative route planning, supplied by the Traffic Control Organization (TCO).

5. Incident reports, fed into the system from 911 emergency lines and other sources.

Most of these information sources do exist, but are not (currently) available as web services. With the possible exception of the alternative route information, creating web services for these systems would be straightforward, given the cooperation of the agencies and organizations involved.

In addition, we implemented two services that are not part of the problem statement but are essential to the operation of the system. The first service is the Web Services Kiosk (WSK). Currently, this is an implementation of the Universal Description, Discovery, and Integration (UDDI) standard, but over time we expect this to evolve into an expanded service that will provide advanced semantic-based discovery services and will be the key to future semantic web services. The second infrastructure service is the Subscription Manager. This is our implementation of a web service that provides the ability for entities in the system to register their interests in information on specific topics, and to publish information that may be of interest to other participants in the system. The information is published as XML documents so that subscribers are not dependent on any static definition of the contents.

The TEGRID Demonstration Scenario: Initial Discovery Phase

The primary visible participants in the demonstration are the Emergency Operations Bureau (EOB) and the two Local Sheriff Stations, Lomita and East Los Angeles. Each of them starts with only one piece of information: the location of the Web Services Kiosk (WSK). The process of discovery is similar regardless of the order in which the three primary participants are started, but for the purposes of this discussion, we will assume that the EOB is started first.

The EOB queries the WSK for the location of a service that can provide publish-and-subscribe functionality. This functionality is defined, as described above, through the use a publicly accessible service model. The WSK finds the only match, which is the Subscription Manager, and returns the Subscription Manager's location (its URI) to the EOB. The EOB also searches the WSK for a service that can monitor power supply levels and send alerts when a power outage is about to begin. The WSK returns the URI of the Power Supply Organization service.

Using the Subscription Manager, the EOB subscribes to notifications about the creation of any Local Sheriff Station (LSS). The EOB also publishes a description of itself, in case there are other elements of the system that have subscribed to the creation of EOB entities. Additionally, the EOB subscribes to notifications of power outages.

Now we start one of the LSS clients – Lomita, for instance. Lomita goes through the same process of using its knowledge of the WSK to discover the Subscription Manager, and registers its interest in receiving messages regarding the creation of EOBs. Lomita also publishes information about itself. Since there is already a subscriber for notifications of LSS creation, the Subscription Manager passes along Lomita's information to the EOB. The EOB adds the Lomita information to its knowledge base, and replies with its own information. Now the EOB and the Lomita station know each other's web location, which means that they can communicate directly with each other, and the EOB has information about Lomita, particularly the RRTs assigned there, and the station resources. When the East Los Angeles station is started, the same process occurs, resulting in East Los Angeles and the EOB learning each other's web location, and the EOB learning all the information that East Los Angeles has provided.

As each participant has entered the system, several agents resident within each one have also subscribed to information on various topics. We will see the effects of these subscriptions in a later phase.

At this point, we have demonstrated the use of two different kinds of discovery. First, there is registry-based discovery, which allowed all the participants to locate the Subscription Manager, and the EOB to find the Power Supply service. Each participant has now created its own awareness of the context in which it is operating, and has exchanged information with other entities in the system. TEGRID has constructed itself in an ad hoc manner, based on available information sources, and has established a loosely-coupled communication system. This is the end of the discovery phase.

The TEGRID Demonstration Scenario: Operational Phase

The operational phase begins when the Power Supply Organization (PSO) determines that a rolling power blackout is imminent (i.e., is planned to begin in fifteen minutes). The PSO publishes that information to all subscribers, which in this case includes only the EOB.

On receiving the imminent power outage alert, the EOB immediately broadcasts the alert to all Local Sheriff Stations. The EOB then uses its Station Monitor Agent to determine which LSSs will experience the outage within their jurisdiction, using the information provided by each station at the time of discovery. These LSSs receive a second alert at a higher priority level. In this scenario, the only station directly affected is East Los Angeles. The EOB also alerts the RRTs assigned to assist the affected stations, so that these RRTs will begin to prepare for deployment. When an LSS receives a power outage alert, it assumes a state of readiness consistent with whether the outage is within its jurisdiction or not.

The second stage in the operational phase occurs when the power outage actually occurs. This is a repeat of the previous step, except that all elements move to a higher state of readiness. The third stage of the operational phase begins with a report of a traffic accident within East Los Angeles' jurisdiction, sent into the system by the Incident Report information source. The East Los Angeles Sheriff Station determines that it does not have sufficient resources to cover the traffic accident due to the power outage. East Los Angeles therefore requests additional resources from the EOB.

The EOB service receives the request and uses its own Scheduling Agent to assign an RRT and other equipment to the traffic accident. In addition, the EOB creates an Incident Agent to monitor further messages relating to the accident.

The fourth (and final) stage of the operational phase begins with the RRT finding that the route to the traffic accident is blocked by traffic due to the fact that many signals are not functioning because there is no power in the area. The RRT requests assistance from the EOB in finding an alternative route. The EOB Incident Agent queries the Web Service Kiosk for a service that implements an alternative traffic route model. The WSK responds with the address of the Traffic Control Service. The Incident Agent sends the request for assistance to the Traffic Control Service, which utilizes its own Routing Agent to determine an alternative route to the traffic accident. The Traffic Control Service sends this route as a reply to the EOB Incident Agent.

At this point, the Incident Agent displays the alternative route to the user of the EOB client system. This allows a human being to examine this route and accept it, alter it, or ask for another

route. Keeping a human in the loop is vital here and at many other places in the system, because the human being will almost always be aware of information that is not available through the system. With the user's acceptance, the alternative route is sent to the RRT, which also accepts it. This concludes the demonstration scenario.

Aspects of the TEGRID Demonstration

The TEGRID demonstration system shows the ability of a system to configure itself based on the available participants and their intents and interests. It also demonstrates the ability of loosely-coupled systems to exchange object-oriented information when the communications protocol is chosen for this purpose. We demonstrated further that participants in a distributed system can extend their awareness of the information available to them, and do not need to rely on pre-defined knowledge of information sources.

On the negative side, we also proved to ourselves the limitations of existing web service standards due to the lack of semantic information. Elements of TEGRID were not required to know exactly what servers they would be using, but we could not eliminate totally the necessity for each element to have knowledge of the interfaces provided by different kinds of services.

Future Directions

As indicated previously, future work will be focused in the area of adding semantic information to the descriptions of services and to the ontology of a service. We will be examining the suitability of the new DAML-Services language for this purpose, by defining representations of the information needs of each participant, and determining whether DAML-S can be used to locate services without an exact match.

We will also be exploring further the use of DAML as an ontology representation language, and creating tools and techniques that will eventually allow systems built around the concept of the semantic web to merge disparate ontologies into a single information model.

Other researchers working in similar areas can be found through articles listed below in the reference section.

References

(It should be noted that there are a large number of resources on these topics, most of which are on the World Wide Web. The following is a short list of starting points, and should not be taken as definitive or complete.)

Special Theme Issue: The Semantic Web, ERCIM News, No. 51, October 2002, http://www.ercim.org/publication/Ercim_News/enw51/

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Graham, Steve, et al., Building Web Services with Java: Making Sense of XML, SOAP, WSDL and UDDI; Sams Publishing, Indianapolis, IN, 2001

McIlraith, Sheila A., Tran Cao Son and Honglei Zeng, Semantic Web Services; IEEE Intelligent Systems, March/April 2001 (pp. 46-5)

Oellermann, William L., Architecting Web Services; Apress, Berkeley, CA, 2001

Pallos, Michael S., Service-Oriented Architecture: A Primer; eAI Journal, December 2001, http://www.eaijournal.com/PDF/SOAPallos.pdf

Appendix A: Semantic Web Services and Network-Centric Systems

A recently announced goal of the Defense Information Systems Agency (DISA) is a move to what has been dubbed 'net-centricity' or 'network-centric'. This goal is directly related to the enterprise architecture known as the 'Global Information Grid' (GIG). As John Osterholz, the director of architecture and interoperability in the Department of Defense's CIO office recently stated: "We believe ultimately that the key to managing data overload is making commanders responsible for pulling the data that they need into their decision space rather than having some galactic, on-line genius decide what they need". (Osterholz's statement was reported on the following web site: http://www.gcn.com/21_29/management/20098-1.html.)

This vision has a deep correlation with the goals of the project described in this paper. In order for each commander (or any other human or software agent) to pull the data (information) that suits his, her, or its current needs, most existing systems would require the user to identify an exact set of information sources. But in a distributed system of the size envisioned by the Department of Defense, it is unlikely that any individual would be able to be aware of all the potential information sources within this network-centric system.

Clearly, a form of automated discovery is necessary for the success of net-centricity. There may be a temptation to repeat past practices and create a (very large) number of standard service models, so that service providers can search registries for service providers implementing those models. If this occurs, commanders using specific client software programs will be restricted to accessing information providers whose models are built into the software. This will be problematic if the commander is in a fluid situation that might benefit from the input of unplanned types of information.

A far more flexible solution will include the addition of semantic descriptions of service capabilities to the discovery system. Client software will then be able to describe the information needs of the user in order to locate appropriate information sources. As the user's needs change, he or she will be able to direct the client software to seek out new services to provide new kinds of information. The result will be the right information delivered to the right person at the right time.

Web services in general also address two other problems that continue to obstruct progress in moving toward transformation of the Department of Defense's information technology systems: interoperability; and ,legacy systems. Web services help to solve both problems by putting a web-based interface on legacy systems. This interface is by definition interoperable with web service clients, which may include other systems that could use the information contained in the legacy system. Adding a web service interface to a legacy system is far more cost-effective than

re-engineering or replacing the system, and in the case of client/server systems, constructing a web service interface can generally be performed over a short period of time, contrasting with the major effort involved in developing replacement systems. Finally, in the case where multiple legacy systems are planned to be replaced by a single new system in the future, the web service interface can serve as a portal that allows clients to access information from the legacy system now, while forwarding requests to the new system as it comes on-line, without rewriting the web service client.

Appendix B: Organizations and Standards

Resource Description Framework (RDF)
http://www.w3.org/RDF/

DAML Organization
www.daml.org
The source for information on the DARPA Agent Markup Language

Semantic Web Working Group of the World Wide Web Consortium
http://www.w3.org/2001/sw/

Web Services Working Group of World Wide Web Consortium
http://www.w3.org/2002/ws/

UDDI
http://www.uddi.org/

WSDL
http://www.w3.org/TR/wsdl

DEMONSTRATION
A system with discovery, reasoning, and learning capabilities.
[ONR Workshop (2002): Wednesday, Sep.18 at 1 pm]

The TEGRID Semantic Web Application

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Introduction

Over the past several years there has been an increasing recognition of the shortcomings of message-passing data-processing systems that compute data without understanding, and the vastly superior potential capabilities of information-centric systems that incorporate an internal information model with sufficient context to support a useful level of automatic reasoning.

The key difference between a data-processing and an information-centric environment is the ability to embed in the information-centric software some understanding of the information being processed. The term ***information-centric*** refers to the representation of information in the computer, not to the way it is actually stored in a digital machine. This notion of ***understanding*** can be achieved in software through the representational medium of an ontological framework of objects with characteristics and interrelationships (i.e., an internal information model). How these objects, characteristics and relationships are actually stored at the lowest level of bits in the computer is immaterial to the ability of the computer to undertake reasoning tasks. The conversion of these bits into data and the transformation of data into information, knowledge and context takes place at higher levels, and is ultimately made possible by the skillful construction of a network of richly described objects and their relationships that represent those physical and conceptual aspects of the real world that the computer is required to reason about.

In a distributed environment such information-centric systems interoperate by exchanging ontology-based information instead of data expressed in standardized formats. The use of ontologies is designed to provide a context that enhances the ability of the software to reason about information received from outside sources. In the past, approaches to inter-system communication have relied on agreements to use pre-defined formats for data representation. Each participant in the communication then implemented translation from the communication format to its own internal data or information model. While relatively simple to construct, this approach led to distributed systems that are brittle, static, and resistant to change.

It is the premise of the TEGRID (Taming the Electric Grid) proof-of-concept demonstration that, for large scale ontology-based systems to be practical, we must allow for dynamic ontology definitions instead of static, pre-defined standards. The need for ontology models that can change after deployment can be most clearly seen when we consider providing information on the World Wide Web as a set of web services augmented with ontologies. In that case, we need to allow

client programs to discover the ontologies of services at run-time, enabling opportunistic access to remote information. As clients incorporate new ontologies into their own internal information models, the clients build context that enables them to reason on the information they receive from other systems. The flexible information model of such systems allows them to evolve over time as new information needs and new information sources are found.

The TEGRID Demonstration Context

Since mid-2001 the Emergency Operations Bureau of the Los Angeles Sheriff's Department has been assigned the additional task of coordinating the response to expected rolling electric power blackouts, as California's demand for electric power came perilously close to exceeding availability. While both the power outage areas and individual blackout periods are predefined in terms of a large number of power grid units that are distributed throughout the Los Angeles County, the emergency events that are likely to be triggered by blackout conditions (e.g., multi-vehicle accidents, carbon monoxide poisoning in enclosed parking garages, fires, criminal activities, and other disturbances) are less determinate.

The TEGRID proof-of-concept system has been designed to assist the Los Angeles Sheriff's Department by addressing this potentially chaotic situation in an autonomously evolving, just-in-time manner. TEGRID does not exist as a pre-configured system of tightly bound components that know about the existence of each other, have predefined connections, and predetermined capabilities. In fact at the beginning of the demonstration TEGRID, as a system, does not really exist at all. What does exist is a set of cooperating Semantic Web Services, based on standard Web Service specifications (e.g., SOAP, UDDI, WSDL, and XML) enhanced by the ability of sharing semantic-level descriptions of their own internal information models.

In essence TEGRID involves sharing information among a number of separate organizations, including local police stations, the Emergency Operations Bureau, a power supply management and monitoring organization, and a traffic control system. The proof-of-concept relies on a set of assumptions about the existing resources available from each of the organizations involved.

1. That each local sheriff's station has a database that includes (at least): current officer assignments; equipment manifests and status; and, priority infrastructure and intersections.
2. That the Emergency Operations Bureau has a list of Rapid Response Teams and their primary and alternative assignments.
3. That there exists some kind of Power Supply Organization that has a database of recent history of power consumption, plus the ability to provide a real-time feed of current power levels.
4. That there exists some kind of Traffic Control Organization that has some method of determining acceptable alternative routes for reaching a particular destination from a given starting location.

Another underlying assumption is that all of these organizations have Internet connections and either have an existing web site or are willing to establish one. TEGRID builds on these existing information and data sources to construct a web service infrastructure that allows information-sharing and automated decision-support.

Since the proof-of-concept system does not have access to live databases, it simulates them, using sample data to implement the demonstration scenario. There are also some potential applications that must exist in order to support the scenario, but are not part of TEGRID itself. For example, there is a requirement that new incidents (e.g., traffic accidents) would be reported to the local sheriff's stations before they are able to propagate through the system. Such a reporting application is assumed to exist, and has been simulated in order to produce the dynamic behavior called for in the demonstration scenario.

TEGRID features several kinds of web service providers. Each of these implements a set of operations that allows exchange of the information that makes the functioning of the system possible. These operations such as subscription, information transfer, warning and alert generation, discovery, and assignment, are the minimum necessary to provide the functionality described in the demonstration. More operations can be easily added as TEGRID's capabilities increase in the future.

In addition, TEGRID includes software agents with automatic reasoning capabilities. Some of these agents could conceptually be seen as services. For instance, the Station Monitor Agent is able to publish alerts that the local stations can subscribe to, and at the same time the Station Monitor Agent is able to subscribe to notifications of planned power outages. The relationship between agents and services is perhaps a fertile field for further investigation: When is it more useful to implement functionality as an agent, and when as a service? Are the two orthogonal? Is it reasonable to think that the same set of functions might be an agent from one point of view, but a service from another? Does an agent consume services, provide services, or both? Since it seems likely that the answers to these questions depend on the nature of the individual agent, the definition of a conceptual framework for making such determinations might be a productive future goal.

The Fundamental Web Service Elements

Within the Internet context of web services, TEGRID builds on a number of standard protocols and elements. These elements are combined into an executing software entity, capable of seeking and discovering existing web services, extending its own information model through the information model of any discovered web service, and automatically reasoning about the state of its internal information model. As shown in Fig.1, this entity or Cyber-Spider consists of three principal components: a web server; a semantic web service; and, an information-centric application.

The web server, utilizing standard Hypertext Transfer Protocol (HTTP), serves as the gateway through which the Cyber-Spider gains access to other existing web services. Web servers primarily provide access to Hypertext Markup Language (HTML) data sources and perform only simple operations that enable access to externally programmed functionality. However, these simple operations currently form the building blocks of the World Wide Web.

The second component of a Cyber-Spider is a semantic web service (i.e., a web service with an internal information model). A web service is accessed through a web server utilizing standard protocols (e.g., UDDI, SOAP, WSDL, SML) and is capable of providing programmed functionality. However, clients to a standard web service are usually restricted to those services that implement specific predefined interfaces. The implementation of web services in the Internet environment allows organizations to provide access to applications that accept and return complex objects. Web service standards also include a limited form of registration and

discovery, which provide the ability to ‘advertise’ a set of services in such a way that prospective client programs can find services that meet their needs. The addition of an internal information model in a semantic web service allows the storage of semantic level descriptions (i.e., information) and the performance of limited operations on these semantic descriptions. In other words, the semantic web server component of a Cyber-Spider is capable of reasoning.

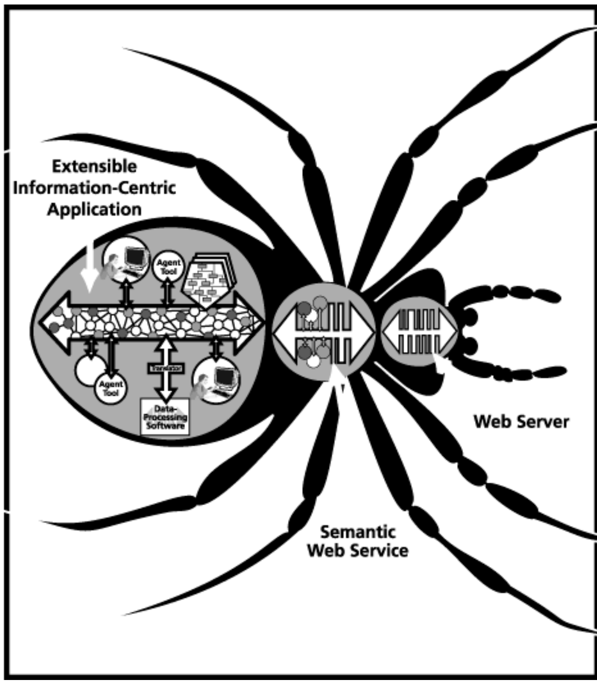

Fig.1: Anatomy of a Cyber-Spider

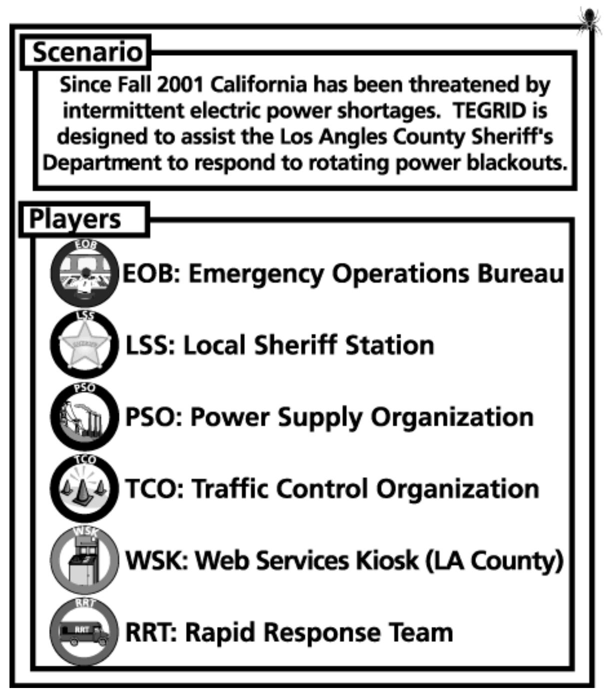

Fig.2: Cast of TEGRID players

The third component of a Cyber-Spider is one or more information-centric applications. These applications are designed to take advantage of the resources provided by a number of semantic web services, enabling them to reason about the usefulness of each service and support more sophisticated discovery strategies. Moreover, the application component is able to construct relationships among the information models of different services, with the ability to integrate services without requiring agreement on a common information model.

With these three components Cyber-Spiders are at least minimally equipped to operate in an Internet environment as autonomous software entities, capable of: discovering needed services; accepting services from external offerers; providing services to external requesters; gaining context through an internal information model; automatically reasoning about available information; extending their information model during execution; extending their service capabilities during execution; and, learning from their collaborations.

The TEGRID Players

The cast of players in the current TEGRID proof-of-concept demonstration includes six players or existing web services (Fig.2): the Emergency Operations Bureau (EOB) of the Los Angeles Sheriff’s Department; several Local Sheriff Stations (LSS); a Power Supply Organization (PSO); a Traffic Control Organization (TCO); several Rapid Response Teams (RRT); and, a Los Angeles County Web Services Kiosk (WSK).

Fundamental to each player are three notions. First, each player operates as an *autonomous* entity within an environment of other players. Most, but not all of the other players are also autonomous. This requires the autonomous players to be able to discover the capabilities of other players. Second, each autonomous player has a sense of *intent* to accomplish one or more objectives. Such objectives may range from the desire to achieve a goal (e.g., maintain situation awareness, coordinate the response to a time critical situation, or undertake a predetermined course of action following the occurrence of a particular event) to the willingness to provide one or more services to other players. Third, each player (whether autonomous or not) is willing to at least *cooperate* with the other players. In some cases the level of cooperation will extend to a collaborative partnership in which the partnering players contribute to the accomplishment of a common objective. In other cases the cooperation may be limited to one player providing a service to another player, without any understanding or interest in the reason for the service request.

To operate successfully in such an autonomous Internet-based environment a Cyber-Spider player should be endowed with the following capabilities:

1. Subscribe to information from external sources
   (e.g., alerts, ontology extensions).
2. Accept subscriptions from external clients.
3. Dynamically change its subscription profile.
4. Extend its internal information representation.
5. Extend its own service capabilities.
6. Generate new agents for its own use.
7. Describe its own service capabilities to external clients.
8. Seek, evaluate and utilize services offered by external clients.
9. Provide services to external clients.
10. Describe its own (intent) nature to external clients.

The Cyber-Spiders in TEGRID are currently capable of demonstrating eight of these ten desirable capabilities. The ability of a Cyber-Spider to dynamically change its subscription profile, while technically a fairly simple matter, has not been implemented because it is not used in the demonstration scenario. The ability of a Cyber-Spider to describe its own nature to external clients, on the other hand, is technically a much more difficult proposition. It will require a Cyber-Spider to have an understanding of its personality as a collective product of its internal information model and the relationship of that model with the external world. At best this must be considered a challenging research area that is beyond the current capabilities of information-centric software systems.

The TEGRID Agents

Most of the reasoning capabilities available in TEGRID are performed by software agents that are components of the players (e.g., Cyber-Spiders). In other words, agents are predefined clients within player systems (i.e., information-centric applications) and perform internal functions that are necessary for the particular player to deliver its services and/or accomplish its intent. The following agents (i.e., collaborative tools) are available in the current TEGRID implementation:

Name of Agent	Owner	Description of Agent Capabilities
Risk Agent	EOB	Identifies high risk entities in the jurisdictional region of an activated LSS.
Deployment Agent	EOB	Determines whether RRT support is required for a particular activated LSS.
Power Level Agent	PSO	Determines if electric power demand has exceeded supply.
Situation Agent	EOB	Prepares and updates the 'EOB Situation Status Report'.
Station Monitor Agent	EOB	Identifies all LSSs that will experience power blackouts during the current and next blackout cycle.
Status Agent	LSS	Prepares and updates the 'LSS Situation Status Report'.
Local Station Agent	LSS	Determines whether sufficient local resources are available to deal with current conditions.
Scheduling Agent	EOB	Assigns RRTs and equipment to situations requiring RRT involvement.
Incident Agent	EOB	Monitors the response to a particular situation supported by one or more RRTs.
Routing Agent	TCO	Determines alternative routes to a particular situation location.

Demonstration Objectives

Stated succinctly, the objective of the TEGRID scenario is to demonstrate the discovery, extensibility, collaboration, automatic reasoning, and tool creation capabilities of a distributed, just-in-time, self-configuring, collaborative multi-agent system in which a number of loosely coupled Web Services associate opportunistically and cooperatively to collectively provide decision assistance in a crisis management situation. Specifically, these capabilities are defined as follows:

Discovery: Ability of an executing software entity to orient itself in a virtual cyberspace environment and discover other software services.

Extensibility: Ability of an executing software entity to extend its information model by gaining access to portions of the information model of another executing software entity.

Collaboration: Ability of several Web Services to collaboratively assist each other and human users during time critical decision making processes.

Reasoning: Ability of a software agent to automatically reason about events in near real time under time critical conditions.

Tool Creation: Ability of a Web Service to create an agent to perform specific situation monitoring and reporting functions.

Players' Intent

The TEGRID players or Cyber-Spiders are initialized with intent or willingness to cooperate based on their role and operational responsibilities, as follows:

EOB (Emergency Operations Bureau): To be immediately informed of imminent power blackout conditions, to coordinate all assistance to LSSs, to maintain situation awareness, and to take over local command responsibilities when conditions require actions that cross the jurisdictional boundaries of two or more LSSs.

LSS (Local Sheriff Station): To activate a predefined response plan as soon as it receives notification (from the EOB) that a power blackout condition is imminent within its jurisdiction, to respond to new emergency missions in its jurisdictional area, to provide RRTs to the EOB, and to request assistance from the EOB.

PSO (Power Supply Organization): To share information relating to the current status of power demand and availability with subscribers, to provide subscribers with information relating to a predefined rolling power blackout schedule on request, and to alert subscribers whenever the schedule is intended to be implemented.

TCO (Traffic Control Organization): To share information relating to historical traffic flows under typical conditions with subscribers, to provide subscribers with information relating to traffic control capabilities (e.g., types and location of traffic signals, sensors, and web-cameras), and to provide subscribers with alternate traffic routes on request.

RRT (Rapid Response Team): To share information relating to its current mission and location with subscribers, to execute missions requested by the EOB, and to provide assistance to any assigned LSS, and to request assistance from the EOB.

The TEGRID Demonstration Scenario

Armed with their individual intent and intrinsic Cyber-Spider capabilities (i.e., ability to: discover useful web services; subscribe to information and accept subscriptions from external clients; extend their internal information models; describe and provide services to external

clients; seek, evaluate and utilize services offered by external clients; and, extend their own service capabilities by generating new agents) the players commence their partly intentional and mostly opportunistic interactions.

Orientation

The players orient themselves in the virtual cyberspace environment by accessing one or more directories of available services and registering an information subscription profile with those services that they believe to be related to their intent (Fig.3).

EOB (Emergency Operations Bureau): Accesses the WSK (Los Angeles County Web Services Kiosk) based on its predefined authorization level, and:

Subscribes to any service changes in the WSK.
Finds the PSO address which it was seeking.
Discovers the TCO.
Discovers all of the LSSs.

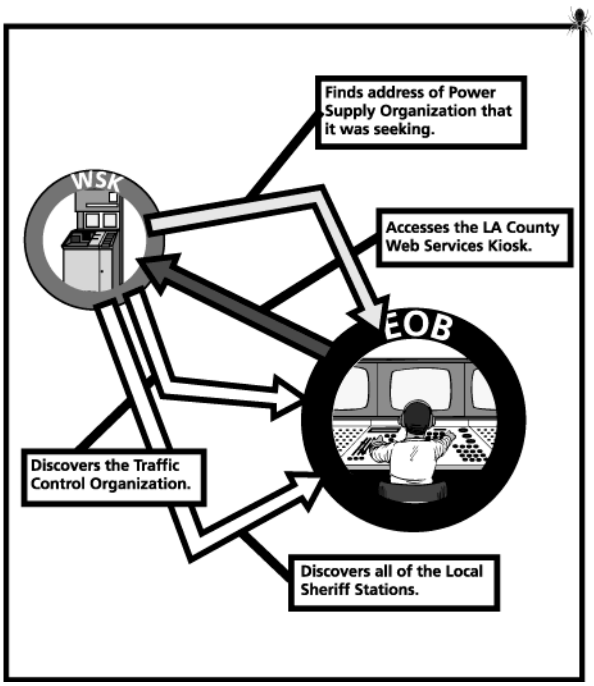

Fig.3: Orientation and discovery

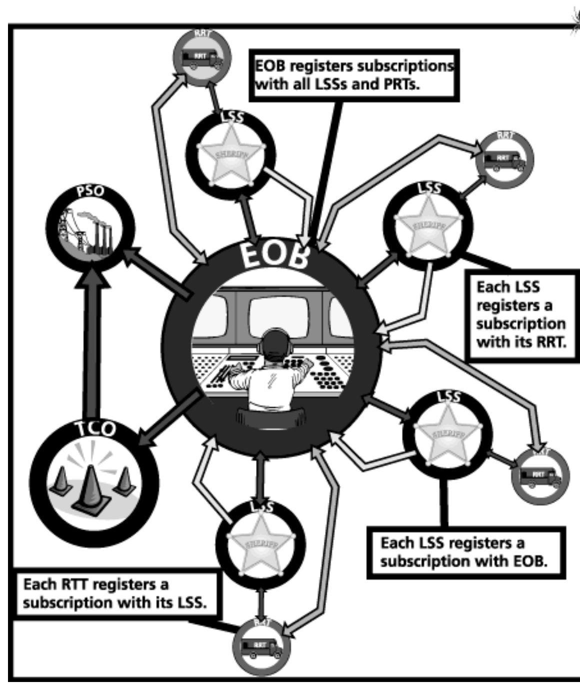

Fig.4: Information subscription

Subscription

The players access the services that they require to achieve their intent, register appropriate subscription profiles, and query for information that they believe to have a need for (Fig.4).

EOB (Emergency Operations Bureau): Registers a subscription profile with each LSS (Local Sheriff Station) that includes all current police unit locations, mission completion events, new mission events, and any information changes relating to the availability of its RRTs (Rapid Response Teams).

Queries each LSS (Local Sheriff Station) for all information relating to its RRTs (Rapid Response Teams) and extends its information model.

Registers a subscription profile with each RRT (Rapid Response Team) that includes its current location and mission.

Registers a subscription profile with the PSO (Power Supply Organization) that includes the current status of electric power demand and availability, and any change in its intention to implement the predefined rolling power blackout schedule.

Registers a subscription profile with the TCO (Traffic Control Organization) that includes any change in the status of traffic signals, sensors, and web-cameras.

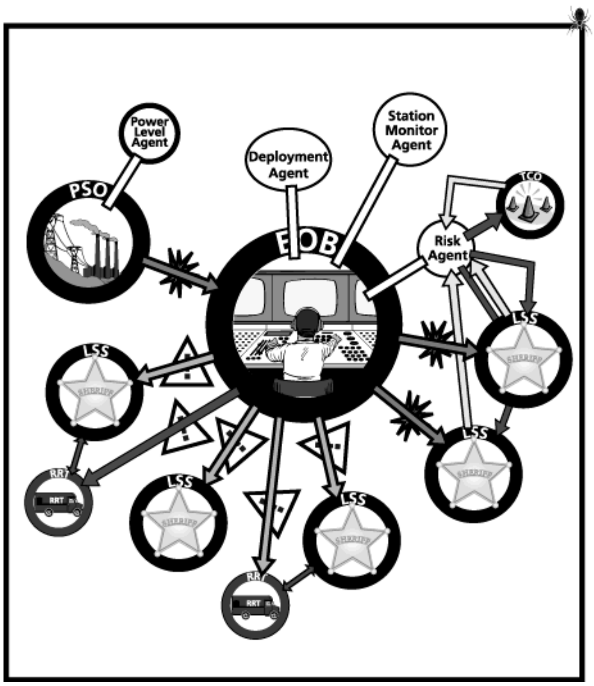

Fig.5: Power supply ‘Warning’

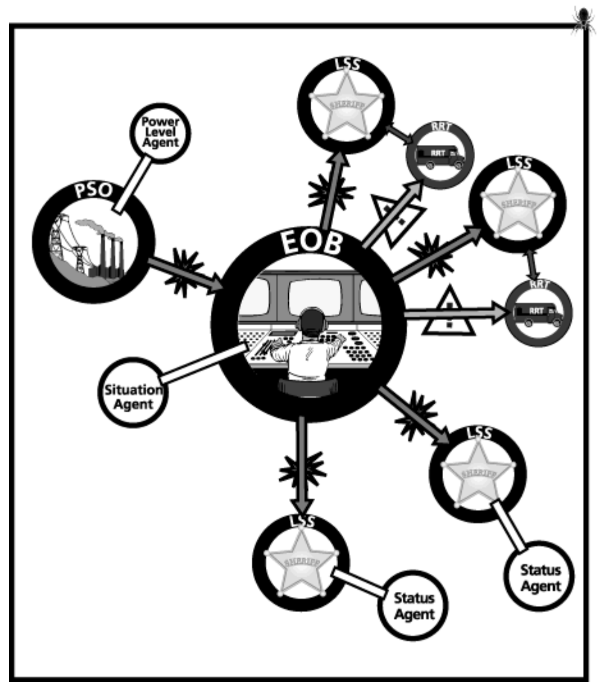

Fig.6: Power outage ‘Alert’

LSS (Local Sheriff Station): Each LSS responds to the EOB (Emergency Operations Bureau) registration by registering a corresponding subscription profile with the EOB that includes the current mission and location of its RRTs (Rapid Response Teams), any EOB requests and orders to this LSS, and changes in the current 'situation status report’ maintained by the EOB.

Each LSS (Local Sheriff Station) registers a subscription profile with its RRTs (Rapid Response Teams) that includes the current mission and location of the RRT, mission completion events, and new mission events (this duplication of its EOB (Emergency Operations Bureau) subscription profile allows the LSS to verify the accuracy of this portion of the ‘situation status report’ maintained by the EOB).

TCO (Traffic Control Organization): Registers a subscription profile with the PSO (Power Supply Organization) to include the location of all current power blackout areas.

RRT (Rapid Response Team): Registers a subscription profiles with the EOB (Emergency Operations Bureau) that includes any requests or orders to this particular RRT (Rapid Response Team), and any changes in conditions that impact the current mission and location of this RRT.

Registers a subscription profile with its home base LSS (Local Sheriff Station) that includes any request for information, and any 'situation status report' maintained by this LSS.

<u>Power Outage Notification</u>

The PSO (Power Supply Organization) alerts its subscribers that a rolling power blackout condition is imminent (i.e., will commence per predefined schedule within 15 minutes) (Fig.5).

PSO (Power Supply Organization): Utilizes its Power Level Agent to continuously monitor the relationship between power demand and supply. The PSO determines that demand is close to exceeding supply and sends an Alert to all appropriate subscribers.

EOB (Emergency Operations Bureau): Receives an Alert from the PSO (Power Supply Organization) that the predefined rolling power blackout schedule will be implemented within 15 minutes.

Utilizes its Station Monitor Agent to identify all LSSs (Local Sheriff Stations) that will experience power blackouts in their jurisdiction.

Warns all LSSs (Local Sheriff Stations) of imminent power blackout condition.

Alerts all LSSs (Local Sheriff Stations) in whose jurisdictions blackouts will occur and requests them to commence immediate implementation of their respective 'blackout response plans'.

Warns the RRTs (Rapid Response Teams) assigned to assist the LSSs (Local Sheriff Stations) in whose jurisdictions the first set of blackouts are scheduled to occur, to prepare for potential deployment.

Utilizes its Risk Agent to identify all high risk entities in the jurisdictions of the activated LSSs (Local Sheriff Stations). Utilizes its Deployment Agent to determine whether RRT (Rapid Response Team) involvement is anticipated under normal conditions.

LSS (Local Sheriff Station): Each LSS assumes 'alert' status. The LSSs in whose jurisdictions the first set of blackouts is scheduled to occur, prepare for deployment.

RRT (Rapid Response Team): The RRTs notified by the EOB (Emergency Operations Bureau) assume 'alert' status in preparation for potential deployment.

Power Outage Implementation

The PSO (Power Supply Organization) alerts its subscribers that the predefined rolling power blackout schedule has been implemented (Fig.6).

PSO (Power Supply Organization): Utilizes its Power Level Agent to determine that demand has exceeded the availability of electric power.

EOB (Emergency Operations Bureau): Receives an Alert from the PSO (Power Supply Organization) indicating that the predefined rolling power blackout schedule has been implemented.

Utilizes its Situation Agent to prepare the first version of the 'EOB Situation Status Report'.

Alerts all LSSs (Local Sheriff Stations) in whose jurisdictions the next scheduled set of blackouts will occur, to prepare for potential deployment.

Warns the RRTs (Rapid Response Teams) assigned to assist the LSSs (Local Sheriff Stations) in whose jurisdictions the next set of blackouts are scheduled to occur, to prepare for potential deployment.

LSS (Local Sheriff Station): All activated LSSs utilize their Status Agent to prepare the first version of their 'LSS Situation Status Report'.

The LSSs (Local Sheriff Stations) in whose jurisdictions the next set of blackouts is scheduled to occur, prepare for deployment.

Traffic Accident in Power Outage Area

A multi-car traffic accident occurs in a blackout area located within the jurisdiction of a particular LSS (Local Sheriff Station) (Fig.7).

EOB (Emergency Operations Bureau): Receives an Alert from a LSS (Local Sheriff Station) that a multi-car traffic accident has occurred on State Highway 5 south of Harbor Freeway.

LSS (Local Sheriff Station): Utilizes its Local Station Agent to determine that it has insufficient resources to deal with the multi-car traffic accident.

EOB (Emergency Operations Bureau): Receives a request for assistance from the LSS (Local Sheriff Station) to deal with the multi-car traffic accident.

Utilizes its Scheduling Agent to assign a RRT (Rapid Response Team) and equipment to the multi-car traffic accident.

Creates an Incident Agent to monitor the response to the multi-car traffic accident.

The new Incident Agent subscribes to the LSS (Local Sheriff Station) in whose jurisdiction the multi-car traffic accident has occurred (to obtain all information about this accident from now on).

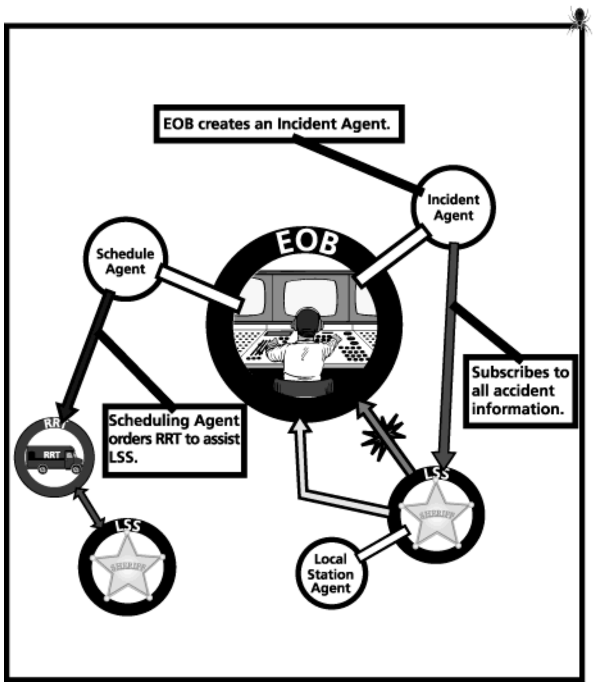

Fig.7: Traffic accident ‘Alert’

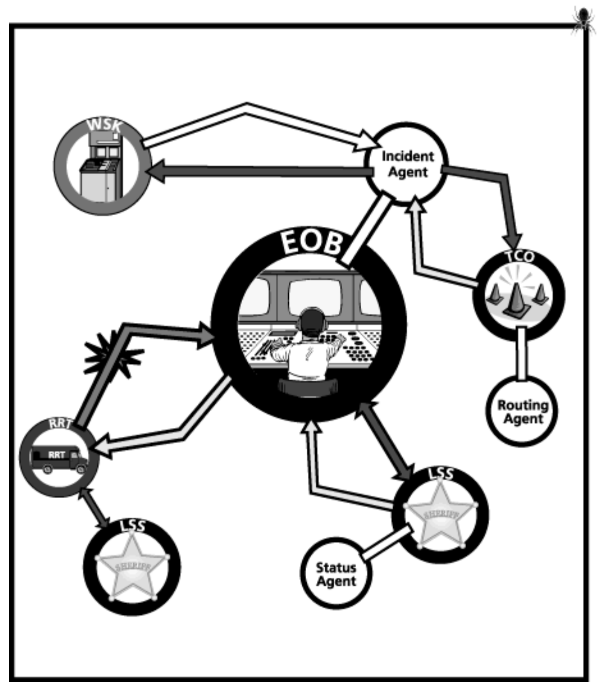

Fig.8: Routing assistance request

Routing Assistance Required

The dispatched RRT (Rapid Response Team) cannot reach the multi-car traffic accident due to traffic congestion and requests assistance in determining an alternative route (Fig.8) to the accident.

RRT (Rapid Response Team): Sends alert to the EOB (Emergency Operations Bureau) and requests assistance in determining an alternative route to the traffic accident.

EOB (Emergency Operations Bureau): Utilizes its Incident Agent to determine an alternative route. The Incident Agent accesses the WSK (Los Angeles County Web Services Kiosk) and discovers the TCO (Traffic Control Organization). It then registers a subscription profile with the TCO that includes routing information, and requests assistance in determining an alternative route to the traffic accident.

TCO (Traffic Control Organization): Receives the request for assistance from the EOB’s (Emergency Operations Bureau) Incident Agent and utilizes its Routing Agent to determine an alternative route to the traffic accident.

Sends the alternate route to the EOB’s Incident Agent..

EOB (Emergency Operations Bureau): Responds to the RRT (Rapid Response Team) by sending it the alternate route to the traffic accident.

Significance of the TEGRID Demonstration

The TEGRID proof-of-concept project was undertaken by the Collaborative Agent Design Research Center (CADRC) at Cal Poly (San Luis Obispo) as a small internally funded research endeavor with three objectives. The first objective was to explore the main capabilities that would be required of web service type entities (i.e., Cyber-Spiders) serving as largely autonomous decision-support components in a self-configuring, just-in-time, intelligent decision-assistance toolkit of collaborating software agents. Second, to determine if the currently available information-centric software technology could support at least basic (i.e., meaningful and useful) implementations of these required capabilities. And, third, to build a working experimental system that could serve as a test bed for longer term research studies focused on the behavioral characteristics of self-configuring intelligent systems in general, and the ability of such systems to deal with specific kinds of dynamic and complex problem situations.

The principal capabilities that are required by a Cyber-Spider to support the desired self-configuring, just-in-time, intelligent decision-support behavior have been identified and demonstrated in the TEGRID test bed environment, at least at a base level of functionality. These capabilities include the ability to: discover desired existing external services; accept and utilize services from external offerers; provide services to external requesters; gain understanding through the context provided by an internal information model; automatically reason about available information within the context of the internal information model; extend the internal information model during execution; spontaneously generate new agents during execution as the need for new capabilities arises; and, learn from the collaborations that occur within the cyberspace environment.

Exploiting Taxonomic Reasoning in Support of Real-Time Mission Reachback Processes

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Abstract

Key information management goals for Naval (SSG, 2000) and Joint (JV2020, 2002) collaborative warfighting include the development of integrated net-centric architectures that enable collaboration among dispersed human decision makers to achieve knowledge dominance and decision superiority during mission planning, preparation, and execution. In particular, the objective is to *transform* decision-making and execution into faster, more adaptive, and more knowledgeable processes. *Reachback* processes, which will permit warfighters to have immediate contact and consultation with remote mission experts, can help meet these objectives. These processes can be facilitated by mission support centers, which will use decision-aiding tools to quickly respond to mission needs. In this invited paper, we describe a functional architecture for decision support activities in reachback processes that integrates several methodologies, including taxonomic reasoning, which extends the mixed-initiative case retrieval paradigm that can help users to quickly retrieve relevant mission experience for their decision-making tasks. This architecture has not yet been implemented; we suggest components for its design.

Keywords: Reachback processes, decision support systems, information-centric architecture, case-based reasoning, process models, knowledge management, local lessons learned processes

1. Transformational Reachback Processes

A *transformational process* is one that can significantly enhance the capabilities of an individual, group, or organization. Typically, it frees those involved to focus on issues associated with its implementation, rather than on how to modify an implementation of the previous process. For example, the introduction of the transcontinental railroad provided revolutionary opportunities for transporting materials and goods that previously were not possible between distant locations.

We define *reachback processes* as *a distributed process for supporting information superiority that achieves real-time mission execution support for remote detachments/units*. This definition fits the example we discuss in Section 1.2. These processes typically include:

- a small forward-deployed HQ (operations),
- a larger rear-deployed HQ (support),
- real-time connectivity between them (e.g., satellite, voice, VTC), and
- real-time communications between the rear-deployed HQ and subject matter experts.

Reachback processes have been used by many commercial organizations to provide diagnostic support to their field technicians (e.g., Xerox (Everett & Bobrow, 2000)) or customers (e.g., General Electric (Cheetham *et al*., 2001)). Navy examples also exist, including a MK 41 VLS troubleshooter that was fielded at the Navy's Fleet Technical Support Centers (Grahovac et al., 1996). It permitted on-ship personnel to solve maintenance tasks by consulting with remote, ground-based experts, thus occasionally saving the costs of flying those experts to the ship.

Transformational reachback processes enable organizations to provide new services. In particular, they can support the real-time sharing of expertise during mission execution.

1.1 Motivation

Reachback processes are *knowledge management* (KM) processes; they focus on sharing information with beneficiaries in a just-in-time context. DoD visions provide strong motivation for developing and nurturing these processes. For example, Joint Vision 2020 (JV2020, 2002) is a Joint Chiefs of Staff concept for the future warfighting ambitions of US joint forces. It extends JV 2010 with recent lessons learned, including the importance of information operations across all warfighting processes. In particular, JV 2020 stresses the need for *full spectrum dominance*, including the need for information and decision superiority, and highlights both technological and human-centric issues. It also predicts that the continued development and proliferation of information technology advances will *substantially change* the conduct of military operations, and the US must employ such technologies where they can benefit warfighting goals. Thus, reachback processes fit the JV 2020 concept; they employ technology to provide remote units with information (e.g., on situation assessment and recommended responses) that can be used to significantly enhance operational decision processes.

Likewise, FORCEnet (SSG, 2000), which is proposed to be the Navy's catalyst for significant transformation, also strongly motivates the creation of military reachback processes. FORCEnet is an integrated and adaptable net-centric architecture that will enable dispersed human decision makers to leverage military capabilities to achieve knowledge dominance during mission planning, preparation, and execution. One of its stated goals is to enable collaborative decision-making. Clearly, reachback processes for decision support is integral to FORCEnet.

1.2 Example

Figure 1 summarizes the fundamental reachback process of the Joint Explosive Ordnance Disposal Knowledge Technology Operational Demonstration (JEOD-KTOD), an Advanced Concept Technology Demonstration (ACTD) that commenced in 2002. In this process, the goal is to provide deployed EOD teams with access to just-in-time operational information (e.g., identifications of explosive devices, suggested neutralization procedures) to assist with their mission (EOD, 2002). It assumes that an EOD technician will relay situation information to Mobile Clients, each of which will be manned by other team members. This client will in turn relay this information to the deployed command's Situation Server, which will be connected by WAN to a Joint EOD Mission Support Center (MSC), whose role is to coordinate, task, track, measure, and maximize warfighter effectiveness by collaborating on all task/mission facets.

Finally, this MSC will have access to mission-relevant contacts "back home", including subject matter experts (SMEs). Given the real-time situation information, SMEs are expected to provide their expertise to assist with remote mission execution. Thus, this process is reminiscent of how field (e.g., copy machine) technicians consult with remote senior experts during troubleshooting.

Another important aspect of this reachback process is that, through connection with EOD training schools, it will potentially improve EOD training procedures. In addition, students will

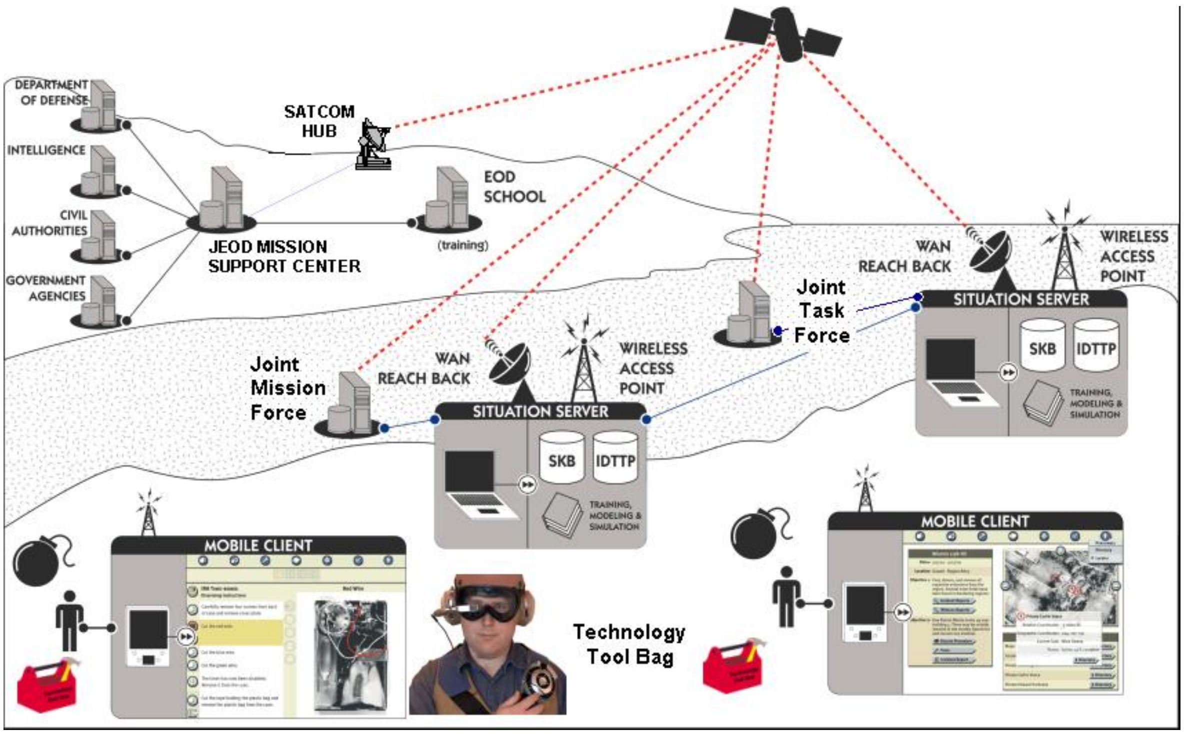

Figure 1: The reachback process envisioned for the JEOD-KTOD ACTD.

benefit from experiencing reachback processes prior to deployment.

Several software and hardware components will support this collaborative decision-making process, including a variety of sensors, IETMs (Interactive Electronic Technical Manuals), and wearable computing devices. In addition, the MSC will have access to a library of documents (e.g., doctrine, TTPs (Tactics, Techniques, and Procedures), AARs (After Action Reports) from previous EOD missions), and relevant databases to assist with mission tasks.

1.3 A Decision Support Need

The scenario presented in Section 1.2 is somewhat idealistic for at least two reasons. First, SMEs will not always be available. Second, experts will not always have immediate solutions ready for the deployed teams. Thus, a key component of this and other reachback processes is a decision support system (DSS) that can assist users with providing timely expertise. In this scenario, the

DSS will be deployed at the MSC and the Situation Servers. Clearly, their capabilities will be crucial to ensure that reachback processes successfully support a wide range of missions and situations.

The JEOD-KTOD ACTD is developing a DSS that will integrate doctrine, (interactive digital) TTPs, training, and operations into a coherent operational picture (based on task, perspective, and situation) via a common language. Rather than discuss specifics of this ACTD's DSS, whose details are sensitive, we focus instead on a more general, research-focused framework for DSS tools in military reachback processes. In particular, we argue that decision support tools for reachback processes should include, among others, the following generic sub-processes:

1. *Situation formulation*: This mixed-initiative process for accumulating situation information should be *situation-driven.* This information can be used to guide the DSS's reasoning techniques and to index data collected by the continuous learning process for efficient retrieval and reuse.

2. *Situation elaboration*: This process automatically extends the situation by using a combination of inferencing techniques, ontologies, and sensor data.

3. *Situation identification*: The DSS should help characterize a situation according to known categories (e.g., type of explosive device). This requires a categorization hierarchy (e.g., implicitly, thru a rule base) and/or a set of previously encountered/categorized situations, where the most similar situation(s) can be used to predict the current situation's category.

4. *Response recommendation*: This should select or formulate a response to the situation, once identified, that decision makers can quickly implement or adapt. This approach may, in many circumstances, significantly reduce the time required to develop responses.

5. *Continuous learning*: This should incrementally populate repositories with <situation, response, outcome> triplets, which can be used for situation identification and response. Also, whenever available TTPs are found to be incomplete or incorrect, the DSS should collect and share lessons with users in a just-in-time information retrieval context,

In addition, the DDS should employ a *mixed-initiative control* strategy in which the system aids the user (e.g., by providing inferencing results to assist with situation analysis) while the user retains all critical decision-making control.

In summary, we advocate a DSS that uses KM methodologies, which integrate relevant technologies and content, to assist with decision-making. This list is incomplete because we focus only on technologies of our interest. In Section 2, we present a reachback DSS architecture for these sub-processes and discuss methodologies for supporting them. We highlight potentially useful research and development ideas for DSS system designers.

2. Functional DSS Architecture

Our architecture is inspired by the information-centric view of decision support systems (Pohl,

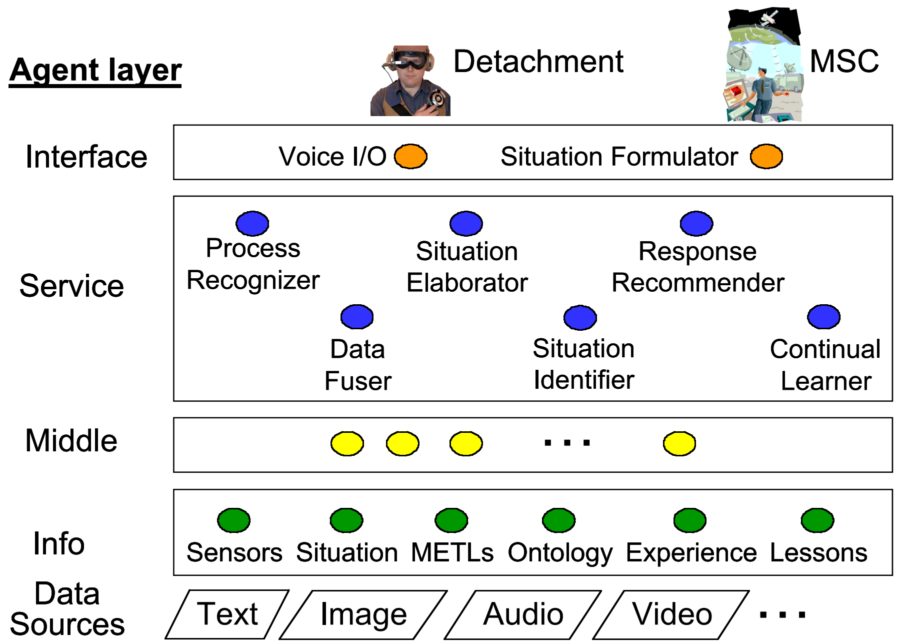

Figure 2: Agent layers for the envisioned Decision Support System.

2001). Briefly, this view notes that stove-piped software solutions greatly limit opportunities for interoperability, and that attempts to achieve interoperability using a data-centric information systems environment are generally flawed. A primary cause for this failure is that these systems cannot incorporate *context* (i.e., situational) into their reasoning processes. In contrast, information-centric systems "embed in the software an understanding of the information being processed" through the thoughtful selection and manipulation of structured information representations. In particular, information-centric architectures typically consist of interacting modules that provide services for clients, where each service module has access to an *ontology* that permits them to communicate information (i.e., the linking of data) rather than more limited data. Typically, in the DSS this involves the following process components:

- Human user(s) (agents)
- Agent software (tools that provide (e.g., reasoning) services)
- Data sources
- Core ontology (provides context)

Information-centric methodologies can potentially accelerate the transition from data-processing to intelligent information management systems by linking these components, such as by extracting information from content through context interpretation so that relevant information can be brought to the attention of the human and software agents. For example, in the EOD context, the human agents would include the deployed detachment teams, MSC personnel, and SMEs. The software agents would support the processes discussed in Section 1.3. Data would include sensor-obtained and related information that define the current situation. Finally, the ontology would represent the mission processes and TTPs used to implement them.

With this view in mind, the following subsections describe an information-centric methodology for designing a DSS for a mission reachback processes. Figure 2 summarizes a multiagent architecture for this DSS, inspired in part by the RETSINA architecture (Sycara *et al.*, 2002), while Figure 3 clarifies some of the functional relationships between selected agents. Selected components of this conceptual architecture will be highlighted in the following subsections, which are organized according to the suggested DSS sub-processes outlined in Section 1.3. Table 1 summarizes the methodologies and artifacts suggested for these sub-processes.

2.1 Situation Formulation

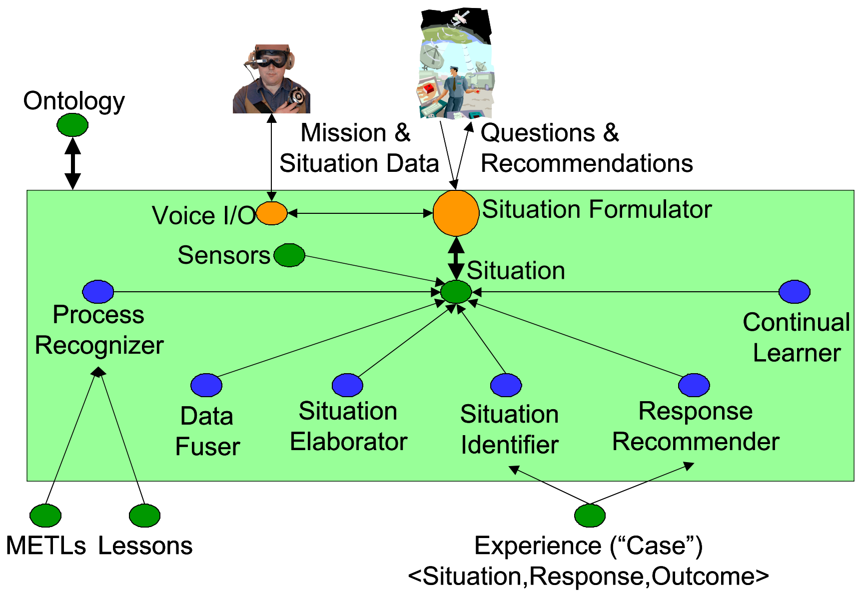

Figure 3: Partial functional architecture for the envisioned Decision Support System.

Table 1: Methodologies and artifacts in support of the decision sub-processes.

Decision Process	Supporting Methodologies	Knowledge Artifacts
Situation formulation	Conversational CBR, taxonomic reasoning	Experiences, ontologies
Situation elaboration	Information gathering	METLs, TMK models, lessons
Situation identification	Machine learning (ML), CBR, data fusion	Experiences
Response recommendation	Conversational CBR, planning	Multi-media sequences
Continuous learning	ML, CBR	Experiences, METLs, lessons

Focusing on the remotely deployed user (e.g., the EOD detachment) and MSC DSS users, we assume that the former will have a more limited bandwidth capacity and would benefit greatly from using interaction modalities other than typed text. We also assume that, as shown in Figure 3, both types of users can provide situation information, which are collected via a Situation Formulator. Many methodologies have been used for capturing situation data. In this subsection, we discuss a case-based reasoning methodology (CBR) that we have extended.

CBR (Aamodt & Plaza, 1994) is a problem solving methodology (Watson, 1999) that focuses on reusing stored problem solutions to help solve new, similar problems. CBR is defined by a sequence of tasks, listed below, that can each be implemented using a variety of techniques:

1. *Request*: Elicit the situation (i.e., *problem*) description from the user.
2. *Retrieve*: Compare a given situation with previously stored cases (e.g., <situation, response, outcome> triplets) to fetch those with best-matching situations.
3. *Reuse*: Select/compose responses (i.e., *solutions*) from the retrieved case(s).
4. *Revise*: Adapt the initial solution to meet the current situation's needs.
5. *Review*: Apply user-provided feedback on the other tasks' results (e.g., Revision).
6. *Retain*: Store, for use in subsequent problem-solving attempts, a new case composed of the current problem, solution, and outcome.

While most of the tasks are simplifications of the tasks described by Aamodt and Plaza (1994), Tasks 1 and 5 were motivated by work on mixed-initiative case retrieval systems (e.g., Aha & Muñoz-Avila, 2001), which have been used in diagnosis and related commercial applications since approximately 1990. For example, Inference Corporation sold CBR development shells and provided services for help-desk and e-commerce applications to over 650 corporate clients. Some other companies that develop CBR shells or apply CBR methodologies (e.g., CaseBank Technologies, empolis, Kaidara) continue to perform well.

An extension of Inference's methodology, which we refer to as *conversational CBR* (CCBR), is potentially useful for designing the Situation Formulator (Figure 2). Cases in CCBR typically contain (1) situations/problems composed of a text summary and a set of <question, answer> pairs (i.e., *conditions*) and (2) a response/solution that is represented in any combination of modalities (e.g., imagery, text, streaming audio). CCBR involves a simple mixed-initiative dialogue that begins when the user provides an initial, typically incomplete, situation description. The system responds by prompting questions, and the user is expected to provide an answer to one of them. This procedure iterates, each time providing additional details concerning the situation. In addition to dynamically re-ranking questions to ask, the system also displays responses corresponding to the best-matching situations among its set of stored cases, and the user can, at any time, decided to implement one of these (recommended) responses.

Several interaction modalities have been investigated for CCBR and related methodologies. For example, CARET's (Shimazu *et al.*, 1994) GUI permits users to enter situation information by clicking on images of a process, diagram, or interface layout, while Giampapa and Sycara (2001) describe a voice interpretation front-end to NaCoDAE (Aha & Breslow, 1997). More recently, CCBR has been used in mobile portals/PDAs (Smyth, 2002; Ito *et al.*, 2001) (e.g., to acquire

situation information for e-commerce applications). Thus, we have some confidence of this methodology's use in mission deployment situations.

Metrics for evaluating CCBR systems include:

1. *Decision recommendation utility*: The recommended responses should be high in quality.
2. *Cognitive effort*: Users should be able to easily determine which questions to answer, and how to answer them.
3. *Problem-solving time*: Users should not have to answer many questions to obtain a satisfactory response suggestion.

The objective is to maximize 1 and minimize 2 and 3. Unfortunately, most CCBR systems fare poorly on these metrics; their commercial success typically relies on expert (e.g., help-desk staff) rather than novice users. Thus, we introduced a *taxonomic reasoning* strategy that strongly constrains the system's question-ranking behavior (Gupta, 2001), based on the observation that <question, answer> pairs in most CCBR cases were often related by subsumption (i.e., concerned the same information at a different level of detail). For example, one such pair might convey information that the mission type was an EOD component of a Direct Action (DA) mission while another might specify this further (e.g., Counter-terrorism mission). Without the system's knowledge of these relationships, the user would always have to supply answers to both questions for the system to work properly (i.e., recommend useful responses). This negatively impacts results for the metrics listed above.

Our solution is to explicate the relations between conditions by creating a separate taxonomy for each set of conditions related by subsumption, where "parent" conditions are linked to their "children" (i.e., immediately more specific) conditions. By exploiting the taxonomies, the dialogue process uses the initial situation to infer which conditions are true. The taxonomic approach then constrains the prompted questions to include only those that are in the child conditions. This *downward traversal* process iterates as more specific information concerning the situation is provided, until a leaf node of each active taxonomy is reached.

The taxonomic CCBR approach has several benefits. First, significant improvements on the metrics summarized above can be obtained in comparison with CCBR processes that are ignorant of condition relations (Gupta *et al*., 2002). Second, this process permits situations in cases to be represented by only their *most specific* conditions, which greatly simplifies the knowledge engineering (i.e., case authoring) process. In addition, the approach is adaptive to different expertise levels; it permits experts to provide initial situation data that is highly specific, thus reducing the number of conditions that they must provide before obtaining a useful response. In contrast, novices may start by providing more abstract conditions, which will require more conditions to precisely define the situation until close-matching cases can be found (if any). Finally, we (Aha & Gupta, 2002) obtained further improvements by adding *causal links* between taxonomies, where each link denotes that one taxonomy's conditions should not be considered until the questions in its "precedent" taxonomy have been answered.

Taxonomic CCBR approaches require taxonomies. We are pursuing a multi-year project in which we have made substantial, though initial, progress on developing information extraction approaches (from structured documents) for populating these taxonomies. Our approach involves

a large number of tasks, including acronym identification, semantic parsing, and concept identification. Although our efforts are not yet complete, we have shown that, if these condition taxonomies can be constructed, then they support excellent mixed-initiative reasoning behavior. Furthermore, we have shown that they actually decrease, rather than increase, overall knowledge engineering requirements for most applications (Gupta *et al*., 2002).

In summary, case-based approaches for mixed-initiative control are one option for consideration in the design of decision support systems for reachback processes. They have been the basis of commercially successful diagnosis systems, they have been integrated with several information modalities that can be applied to reachback processes, and recent research has improved them according to evaluation metrics of interest. While this section focused on their potential role in Situation Formulation, later sections discuss how they can potentially facilitate other components of the DSS functional architecture (Figure 3).

2.2 Situation Elaboration

Situation elaboration involves exploring a process's *context*, which includes the *mission* being performed, its *trace* (i.e., how the mission is being performed; the sequence of steps), the current mission execution *step* being performed, and its *task(s)*. The DSS situation identification and response recommendation processes require this information to provide context-relevant recommendations. Thus, the Process Recognizer (Figure 3) must identify a mission's context from its execution trace to inform the subsequent sub-processes (i.e., identification and response). Also, it can be used to augment the situation description, as we will discuss.

Generic situation information is provided in standard military documents, such as doctrine, TTPs, and related (e.g., Naval Warfare) publications that describe essential mission organizations, steps, and resources. However, more specific mission planning guidance exists in the form of Mission Essential Task Lists (METLs), which describe, hierarchically, the set of tasks to be performed in a given mission. Tasks in METLs are extracted from the Universal Joint Task List (UJTL, 2002) and service-specific (e.g., tactical) extensions, such as the Universal Naval Task List (UNTL, 2002). The UJTL is a hierarchical, standardized task list that describes requirements for planning, conducting, evaluating, and assessing joint and multinational missions. It primarily focuses on the strategic and operational levels. The UNTL, which combines the UJTL with the Naval Tactical Task List (NTTL), is a hierarchical master menu of Naval tasks, conditions (i.e., concerning variables in the environment that can effect the performance of a given task), and performance measures that provides a common language and structure for the development of Naval METLs (NMETLs).

The Process Recognizer could exploit these METLs for situation elaboration. However, these task lists are limited: they identify *what* is to be performed, in terms common to all services, but they do not address *how* a task is to be performed (found in Joint or Service doctrine), nor *who* is to perform the task. (These issues are instead addressed by other resources, including CONOPS, conditions, measures, and doctrine.) We seek an approach for modeling context that addresses all three issues. One possible choice is to use Task-Method-Knowledge (TMK) models (Murdock & Goel, 2001), which represent task hierarchies, and methods for decomposing tasks. A TMK model can represent multiple execution traces and explicitly identify task parameters (e.g.,

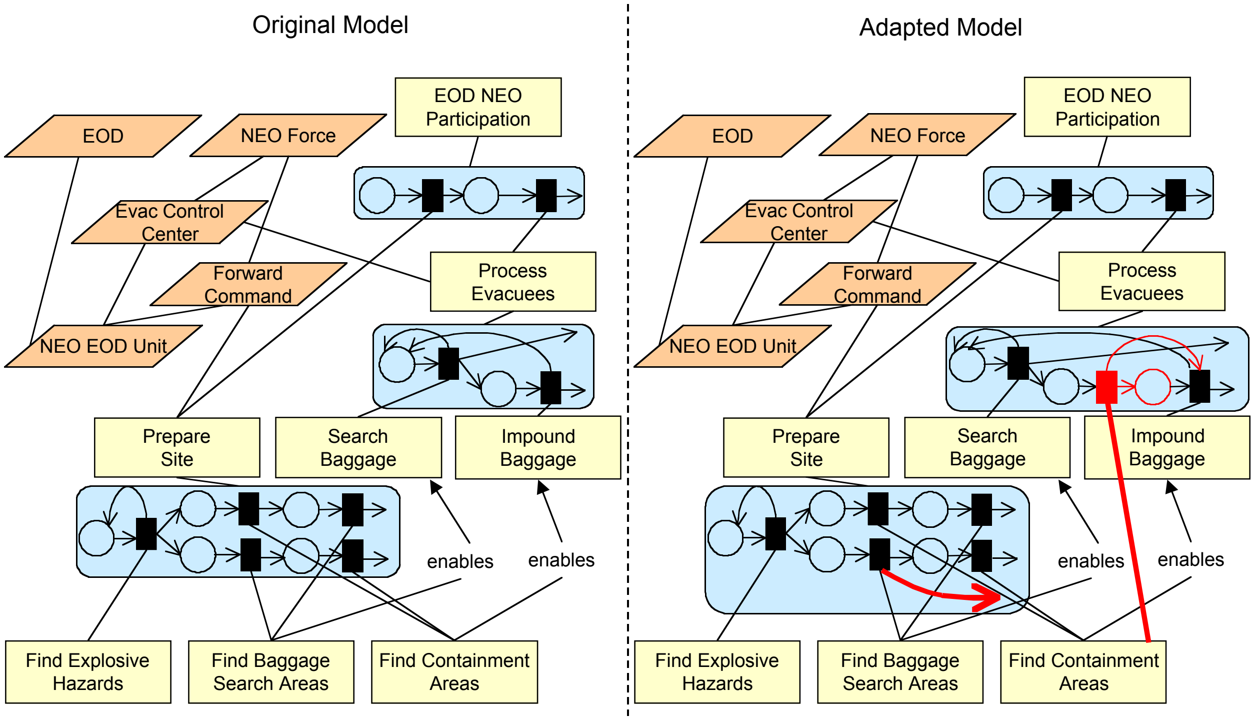

Figure 4: The TMK model on the left encodes a simplified process for EOD participation in a NEO. The figure on the right shows an adapted version of the model that reflects a possible change in doctrine based on additional mission experience. Differences between the two models are noted in red.

participants, locations, targets). Figure 4 shows an example with two versions of a simplified EOD mission, where tasks are denoted as boxes, parameters (specifically, participants) are denoted as oblique parallelograms, and methods are denoted as rounded boxes containing state-transition diagrams. In this figure, the EOD/NEO task has a single method that decomposes it into two subtasks: preparing the site and processing the evacuees. Those subtasks each have a method that further decomposes them into primitive tasks. The participants are arranged according to organizational structure (for example, the *NEO EOD Unit* is part of both *EOD* and the *NEO Force*). Because methods can contain both loops and branches, they can support many alternative traces, but not necessarily all possible traces. For example, the *Search Baggage* task in the Original Model may be followed by the *Impound Baggage* task, another *Search Baggage* task, or by the method's end (as denoted by the three arrows emanating from the box connected to *Search Baggage* in the method for *Process Evacuees*). Also, tasks contain additional information on how they interrelate (e.g., *Find Containment Areas* directly enables *Impound Baggage*).

The Process Recognizer could use TMK representations of METLs to elaborate the mission context (i.e., as performed by the Situation Elaborator in Figure 3); it could use them to actively recognize which trace is being executed, thus anticipating what subsequent tasks will be executed. These anticipated tasks could then be used to help focus the situation identification and response recommendation sub-processes. Some automated situation elaboration techniques have been incorporated into CCBR systems. For example, Carrick et al.'s (1999) system triggers pre-created situation elaboration plans upon receiving partial situations, while Aha et al. (1998) describe a model-based approach for inferring situation data automatically. Also, CCBR systems,

which have previously been used only for diagnosis tasks, have been extended for use in mission planning tasks (e.g., Abi-Zeid *et al.*, 1999; Muñoz-Avila *et al*., 1999).

As with taxonomic CBR, a key concern with using TMK models is knowledge (i.e., model) acquisition. In a recent JEOD-KTOD contract, Dynamic Research Corporation extended task lists for EOD-specific METLs of land mine warfare missions. They encoded tasks using the DARPA Agent Markup Language (DAML, 2002), which is a WWW text markup language that enables the encoding of entities and relations (e.g., tasks and their assigned units). A future version of DAML (i.e., that has mature tools for editing ontologies) could be used to represent the ontologies necessary for DSS tools in mission reachback processes. This approach could potentially be used to encode context information for information-centric mission support systems and to encode TMK models of EOD processes.

TMK models can be used to incorporate METL and doctrine adaptations. We discuss this further in Section 2.5.

2.3 Situation Identification

The Situation Identifier, which will receive situation data encoded in multiple types of media (e.g., text, photography, graphics, audio/video), will use data fusion techniques (performed by the Data Fuser in Figure 3) to permit subsequent reasoning (Goebel, 2001). This process will depend on using ontologies to interpret and relate the contributions of each data source.

The Situation Identifier could use a combination of one or more of the following three approaches. First, situations can be categorized, for subsequent response purposes, using an expert system containing a set of categorization rules, or by an alterative approach that maps situations to identifications. Although this approach is popular and straightforward, its knowledge acquisition and engineering costs are high.

Second, if the experts can more easily provide situation-identification experiences, then experiences could be collected and a mapping could be induced automatically using a supervised rule-induction algorithm (Mitchell, 1997; Fürnkranz, 1999). If successful, this approach could alleviate the need for SMEs to provide the rules, leaving this task to the system. However, although rule-induction algorithms have reached a high-level of maturity, and have even been extended to work with expressive representations such as versions of first-order logic, they are rarely applied to significantly complex problems with abundant relational structure (e.g., temporal, organizational). Thus, this approach would probably need significant extension for use in mission planning applications.

A third approach, naturally, is to not generalize the experiences, but to instead use similarity computations (between the current situation and stored <situation, identification> "cases") to map situations to identifications. This has the benefit of not requiring abstractions (i.e., rules) of the experiences, but introduces the problem of creating the similarity functions, and associated indexing structures, to support an efficient and accurate retrieval process. As mentioned earlier, this is a focal interest of CBR systems. However, only a few existing commercial CBR tools (e.g., empolis' orenge architecture) and research systems (e.g., the FIRE Analogy Server (Forbus, 2001)) can process data represented in relational format, which we anticipate will be the

representation of choice for encoding situations. Nonetheless, there is significant, ongoing interest in developing CBR systems that can process object-oriented (Bergmann & Stahl, 1998) and relational structures, and their capabilities have quickly increased in recent years.

2.4 Response Recommendation

Like situation identification, the DSS response recommendation task could require working with multiple media types (e.g., streaming audio/video, imagery, text, graphics). Responses may vary from retrieving potentially relevant information for the user (e.g., procedures for safely detonating an unknown explosive device) to queries for additional situation data. As explained in Section 2.1, the CCBR approach is designed to support situation elicitation tasks of this type, and could be potentially useful for producing a recommendation.

For example, one mission objective, in the context of an EOD Neutralization task, might be to retrieve an audio/video stream segment that presents how an expert would neutralize a similar explosive device. While some CBR systems have been used to retrieve audio/video streams in which experts provided advice on how to perform mission tasks (Johnson *et al*., 2000), these videos had to be retrieved by manually searching a hierarchical task structure, and individual segments of videos (e.g., that focused on specific subtasks) were not themselves retrievable. A far more flexible capability is one that permits the retrieval of arbitrary audio/video sub-streams.

Few CCBR efforts have focused on using a large variety of media. However, CCBR systems can be extended to include multimedia information. For example, one commercial product that supports this capability is StreamSage (2002), which permits the retrieval of indexed intervals within an audio/video sequence. This is particularly useful if the sequence is long (e.g., an hour or more), and many topics are covered in the stream (e.g., in videos capturing the expertise of departing officers or employees). StreamSage, which automatically indexes audio/video streams for subsequent retrieval of useful segments, currently uses a limiting, simple keyword search approach for sequence retrieval. We are exploring an integration of StreamSage with our CCBR tools to support response recommendation in which the latter provides situation information to StreamSage. In this way, the CCBR tool would elicit indexing information required by StreamSage, thus guiding the user in this process.

2.5 Continuous Learning

The objectives for continuous learning are to add missing, mission-relevant information to the DSS that can be used in subsequent missions, to serve as a key source of information when experts are not available, and to provide a means for adapting the doctrine and mission execution processes. In this subsection, we discuss three types of information that could be targets for the learning process: mission experiences, METLs, and lessons.

Mission experiences, captured as cases, could be employed in the situation elaboration, situation identification, and response recommendation processes, provided that the DSS is given mission execution performance results and is designed to monitor, capture, and properly index user interaction behaviors. For example, in a situation elaboration process, learning could focus on identifying information sought by a user and reuse it when encountering similar contexts. If the

system recognizes that a user regularly requests or obtains certain types of situation data during Direct Action missions, then in future DA missions, the acquisition of this data could be automated, if feasible, or the DSS could remind the user that they requested it previous, similar circumstances. During situation identification, if the user provides feedback on the mapping of a situation to a successful identification, then this information could be cached to improve this mapping in future missions. Failed identification attempts could also be useful, especially if it conflicts with the user's conclusion for a subsequent identification attempt. In this circumstance, the system may be designed to warn the user. Finally, in response recommendation, a similar approach could guide the user towards successes and away from failures incurred in previous response attempts.

METLs could also be updated over time, with the potential benefit to both ensure they are current and to provide users with insights into how previous teams executed the same type of mission in similar situations. Assuming a TMK model representation, then additional tasks, mission traces, and conditions that govern the selection of task decompositions could be learned for mission METLs by updating these models (i.e., by observing and storing decision-making behaviors). For example, if a user conducts a mission using a non-standard process (i.e., METL) that involves a novel task sequence, then it may be recorded with the evolving METL so that it is available for inspection and consideration in future missions. Incremental adaptation in response to novel demands has been a central theme of TMK research (e.g., Stroulia & Goel, 1995; Murdock & Goel, 2001). The contrast between the two models in Figure 4 illustrates METL adaptation. The left-hand model represents standard procedure (EOD, 2002), while the right-hand model depicts the results of the following hypothetical scenario.

Suppose a forward command element, while preparing an evacuation site, first searches for explosive hazards and then finds some areas for searching baggage. However, they decide to not yet locate an appropriate area to contain suspect baggage, and instead the evacuation control center begins immediately processing evacuees. While searching baggage they encounter a suspect item and then search for a containment area. Once found, they impound the baggage, and continue with the baggage search. After the NEO is complete, an analysis might conclude that the decision to delay finding a containment area was correct under the circumstances and that doctrine should be revised to accommodate this alternative sequence of actions. The right-hand model in Figure 4 reflects this change; the *Find Containment Areas* task can now be invoked from either the method for *Prepare Site* or from the method for *Process Evacuees*. Other modifications could be made to the model that would also accommodate this particular sequence of actions (e.g., one could include a *Search Baggage* action in the method for *Prepare Site*). Information in the model can be used to select sensible revisions. For example, because *Find Containment Areas* directly enables *Impound Baggage*, it is more reasonable to place the former immediately prior to the latter than it is to move a separate task such as *Search Baggage*. Thus TMK models can enable a DSS to recommend specific model revisions given a new action sequence (i.e., mission execution trace).

The DSS must also be able to explain its decision to the user for it to be acceptable. Towards this goal, decision rationale needs to be captured for subsequent inspection, and this is one objective of the Continual Learner (Figure 3). In particular, the characterization of situations

under which one mission trace should be chosen rather than another (at a decision point) can be difficult, requiring a topology of situations to frame the learning process.

A third and perhaps most important focus of a continuous learning process is that of identifying, capturing, and sharing lessons, which are experiences that, if known and used, could significantly impact future mission performance variables. In mission reachback processes, lessons could refer to discoveries in which the available doctrine, TTPs, or other information sources were found to be lacking either because they were incomplete or incorrect. For example, the doctrine for neutralizing an ordnance might become outdated, and not explain that a new feature for identifying certain ordnance could provide key information on how to disarm it. Rather than change the doctrine, which could take time and could also be risky (e.g., interfere with procedures for neutralizing unchanged types of ordnance), a lesson could be learned that, under similar future situations, alerts the EOD team to the new, distinguishing features of the ordnance that they should consider during neutralization attempts. With this goal in mind, we developed a representation for lessons and a *monitored distribution* approach in which an embedded lesson repository is proactively and automatically searched throughout the DSS session, where lessons that closely match the current situational context (e.g., task, mission trace) are brought to the user's attention (Aha *et al.*, 2001; Weber & Aha, 2002a). This approach for capturing and sharing lessons avoids some of the cultural problems encountered by organization-wide lessons learned efforts (e.g., NLLS, JCLL), in which many good lessons are not recorded due to the negative career implications with sharing them. Rather, as with other successful lessons learned processes, lessons recorded and shared in this context would remain with the command that executes the mission. In general, this type of *local* lessons learned process reduces concerns of sharing lessons outside a Community of Practice (CoP), and focuses on sharing with other members in the CoP rather than through vertical chains of command.

3. Needs

In this paper, we outlined some suggestions for designing decision support systems for mission reachback processes. Few such systems are currently deployed in the military, and those that do exist are still evolving. In Section 1.3, we argued that these systems should support five key sub-processes. In Section 2, we suggested a functional architecture for supporting them, along with specific suggestions for implementing some of these functions.

Several advances must occur prior to the development and deployment of reachback DSS systems with these characteristics. For example, while CCBR systems have performed well for diagnosis tasks and we know how to design them to work with voice input and other modalities, their dialogue capabilities are limited. However, some recent research has begun investigating the use of formal dialogue grammars for CCBR systems (Bridge, 2002), which should lead to analysis of how to design appropriate dialogues for mission reachback purposes. Another hurdle is the continued design and analysis of induction algorithms for TMK models, or similar process models that can be used to represent METLs and other mission-context information. Next, DAML, a significant contribution to developing semantic WWW services, was born only recently and will require more sophisticated ontology development and maintenance tools. Also, guided elicitation tools, such as the Lesson Elicitation Tool (Weber & Aha, 2002b), are needed to help capture information to support continuous learning objectives. Additional development

requirements, both technological and otherwise, also exist, including conducting cognitive task analyses for designing the interfaces of these decision support tools.

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An Analysis Tool Suite for Management and Reuse of Ontologies

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Abstract. Intelligent multi-agent decision support systems depend heavily on ontologies to perform their functionalities. This paper addresses the building, maintaining and reusing of ontologies in a cost-effective manner. We advocate a round-trip engineering methodology towards this goal by first using Pragati's Multi-ViewPoint Clustering Analysis approach to analyze existing ontologies. Results from this analysis identifies reusable components which will populate the model fragment repository of Pragati's Façade Creation Toolkit. Such an infrastructure will allow ontological engineers to extend and/or recast their ontologies for different applications in a cost-effective manner.

I. Motivation

Intelligent decision support systems often utilize multiple software agents for performing various tasks. Software agents depend heavily upon knowledge representation schemas specified through an ontology in order to perform their reasoning tasks efficiently. Agent reasoning and collaboration takes place in the context of such an ontology. The bulk of the effort in building such multi-agent systems lies in specifying the underlying ontology in an optimal manner. As ontologies become large, the human-oriented solution for recasting ontologies does not scale up. In practice, the design issues in an ontology often gets influenced by the need to solve the problem at hand in an optimal fashion, instead of trying to formulate an ontology in generic terms keeping in mind its reuse potential for other projects. That is, the level of detail for an entity definition, its placement in the ontological hierarchy reflecting its relationships to other entities in the ontology, all get influenced by the overall problem solving goals for the agent(s) that will use the ontology in a given context, instead of being generally applicable. Even though ontological engineers can often provide insight into the types of modifications needed to render the old framework reusable for the new problem, as ontologies grow, the human-oriented solution is not cost-effective. The cost of understanding the complexities in the current ontology, recasting the new problem in the old framework, and then deciding what changes should take place in the old ontology to effect a natural problem formulation, is often an expensive proposition. The frequency with which old ontologies need to be recast as well as the extent to which they need to be recast, warrants that a high level approach be taken towards semi-automating some of the ontology redesign tasks. Justification for building such an environment lies in the cost savings due to amortization of ontology design for multi-agent systems over several different projects.

Tools and techniques are needed for automating the process of ontology redesign for new projects. Smart software analysis infrastructures are required for analyzing existing systems that can expose potential reusable regions. Our approach is based on a round-trip software engineering methodology that first identifies and extracts candidate

reusable regions from software systems. This technology then dovetails into another framework that allows an ontological designer to extract relevant ontological fragments and build larger ontologies based on his/her requirements.

In this paper we first describe the basic aspects of defining an ontology and provide some example ontologies of varying complexity. This will be followed by a short description of the Multi-ViewPoint Clustering Analysis (MVP-CA) tool that helps expose ontological engineering concerns as well as aids the user in extraction of reusable software regions from axiomatized ontologies. Finally we provide a high-level view of the Façade Creation Tool kit (FCT) that provides the user the flexible perspectives on an existing ontology, given the revelations made by the MVP-CA tool. It further allows the ontological engineer to morph the ontologies as facades for adaptation and utilization in the current application environment.

II. Background on Ontologies

An ontology is an explicit formal specification of terms in a domain and the relations among them. Terms are defined in the context of concepts that arise in a particular domain of discourse. Conceptualization of terms depends both on the objects of interest in the operational environment, as well as their intended usage in the operational environment. Thus, the level of granularity at which the concepts get defined as well as their inter relationships with other objects of interest in the environment all get influenced by the intrinsic characteristics of the objects as well as the operational characteristics of the environment in which they will be used.

The need for ontology arises from the fact that ontologies enable formalisms to be applied on the semantics of concepts so that automated reasoning can proceed with those concepts to enable the desired functionalities in any system. Also, for systems operating with multiple agents, interoperability and collaboration among them can be made possible if there exists a common formal lingua between these systems to communicate with each other meaningfully.

The basis for formulating an ontology lies primarily in defining the concept classes for the system – based on the commonalities across the characteristics of the objects of interest. One needs to be careful in how we define these classes as they need to have enough ontological distinctions among them in order to facilitate establishment of a meaningful hierarchy across the concepts. For the concept classes that do not have a hierarchical relationship to other classes, interdependencies and associations among concepts can be captured as a network of interrelationships. The guiding principles for optimizing the ontological design should lie in observing and adhering to the following few tenets:

- *parsimonious* design of concept classes
- *crispness* in the distinctions across concepts
- *richness* in the associations across concepts

We will briefly provide some example ontologies next that vary in complexity progressively. They are meant to expose the reader to above aspects involved in ontology design.

At a very simple conceptual level, we can succinctly capture the relevant aspects of a blocks world represented in Figure 1, through the following ontology. We basically need only a set of two concept classes: *{block, table}*. The set of instances of these

concepts are *{a, b, c, d, e: block; T: table}*. The relationships which need to be defined to capture the environment specifics are the following: *{on(d,c), on(a,d), on(T,a), on(b,e), on(T,b), clear(c), clear(e)}*.

A more useful and well-studied example of an ontology lies in the taxonomic classification of species in application areas, such as, biology, botany, etc. The classification ontology shown in Figure 2 is based on well-understood distinctions across various animal types. Such an ontology facilitates the classification and study of the behavioral characteristics of the different species in the animal kingdom.

Figure 3 provides an example ontology fragment for various military unit specialty types, such as, services unit, logistics unit, etc. Under the airborne specialty unit, for the helicopter we see a forking of the classification according to whether one is talking about the helicopter unit in an attack mode (e.g. for tactical operations) or a lift mode (eg. for logistics operations). The definition of heavy, medium and light for the same helicopter will be different given the two functionalities. Thus, we see how the operational characteristics of the environment can play a major role in defining our interrelationships for the objects of interest in the environment.

The reality is that no single ontology is correct for all applications. Even though the choice of ontological distinctions and concept placements are made with respect to a **projected usage** of the ontology, in reality, **actual usage** reveals more optimal ways of organization of the ontology. If we are willing to accept this reality, it follows that ontological engineering is an open-ended task. We need tools which can render ontologies adaptive and open to different types of application demands.

III. Multi-ViewPoint Clustering Analysis Technology

Pragati's Multi-ViewPoint Clustering Analysis (MVP-CA) tool facilitates analysis of semi-structured software systems (such as knowledge bases) by clustering meaningful information entities (such as KB rules), into clusters that share significant common properties [Mehrotra & Bobrovnikoff (2002)]. It exposes ontology developers to the usage of the ontology by clustering the information units that exercise/use the ontology in a given practical context. In its current state, MVP-CA tool can accept many different types of axiomatized ontologies in the form of knowledge bases or decision support systems.

The MVP-CA tool consists of three stages: parsing, cluster generation, and cluster analysis. In the parsing phase, a front-end parser translates a knowledge base's axioms from their original form into a language-independent representation. The user can specify numerous rule and pattern transformations in this stage to eliminate noise in the data. The cluster generation phase applies a hierarchical agglomerative clustering algorithm to the transformed rules. During each iteration, the two most similar clusters merge to form a new cluster. The order of merging forms a hierarchy of clusters. Similarity between rules is defined by a set of heuristic distance metrics [Mehrotra and Wild 1995] that the user chooses based on the nature of the task performed by the rule base (e.g., classification, diagnosis, control, etc.). These heuristic-based distance metrics have evolved from our experiences with different types of knowledge bases. In the cluster analysis phase, the user interacts with the tool to pinpoint the relevant clusters from the generated pool of clusters. A cluster's relevance depends entirely on the objective of the analysis. However,

the tool does provide some automatic support for common analysis goals, such as flagging clusters whose rules contain very similar clauses.

In its primary role as a comprehension aid, MVP-CA provides support for zeroing in on clusters that provide insight into the important conceptual regions in the knowledge base. In order to identify such seed concepts, the tool generates different types of information about patterns and clusters. The user can utilize this information to assess the quality and relevance of the clusters. Graphical representations of the clustering process, such as dendrograms, further aid the user in establishing links across various concept terms in the knowledge base. In addition, the tool provides several views of the clusters at the pattern, rule, and cluster levels to aid the user in identifying the relevant clusters. We currently have a rich repertoire of automatic detection routines for flagging clusters that are relevant according to common analysis goals.

Clustering of knowledge bases into groups of semantically-related rules/axioms reveals relationship of terms in the context of their usage and also exposes prototypical patterns of usage for the terms in the knowledge base. Multiple ways of clustering the system, based on different objective criteria for grouping, aids in understanding and analyzing the system from different perspectives. Our contention is that no single clustering is sufficient to understand complex systems – multiple viewpoints of the domain provide different perspectives of the system.

IV. Analysis Insights through MVP-CA Technology

In our experiences of analyzing axiomatized ontologies through the MVP-CA tool we have discovered the following major issues which complicate the maintenance and reuse of ontologies [e.g. Mehrotra et.al (1999)].

- **Level of Abstraction of Concepts:**

In general we have noticed that either concepts are too specialized in the core ontology which precludes its usage in different contexts or they are too generalized so that their meaning gets overloaded due to the different contexts in which they get used.

Overspecialization of concepts in the core precludes users from seeing the forest for the trees. For example, if different types of cars, such as, Ford Taurus, Toyota Camry, Honda Accord, etc. are declared as concept classes in the core, one needs a generalized concept of an *automobile* to capture the commonalities among them. Clustering aids us in abstracting or generalizing such concepts in the core so that they become reusable for future development efforts.

An opposite extreme of the above case is when a concept is declared as being too general. This often leads to an open interpretation problem when comprehending or extending the knowledge base, because the concept changes its meaning depending on the context of its usage. An example of such a concept class is Move. It is too general a concept and more than likely, it needs to be specialized to Move-Into, Move-To, Move-Out-Of, Move-Through, etc. in order to differentiate across its many varied uses.

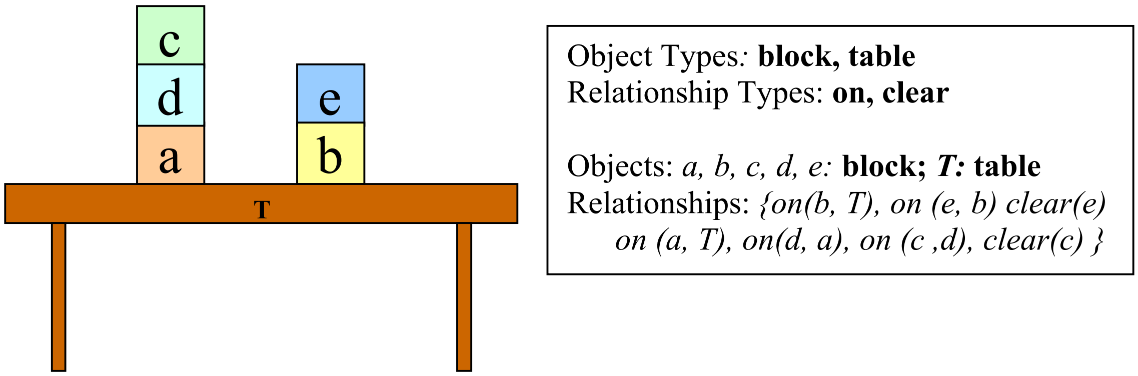

Figure 1: *Simple Ontology for a Blocks World*

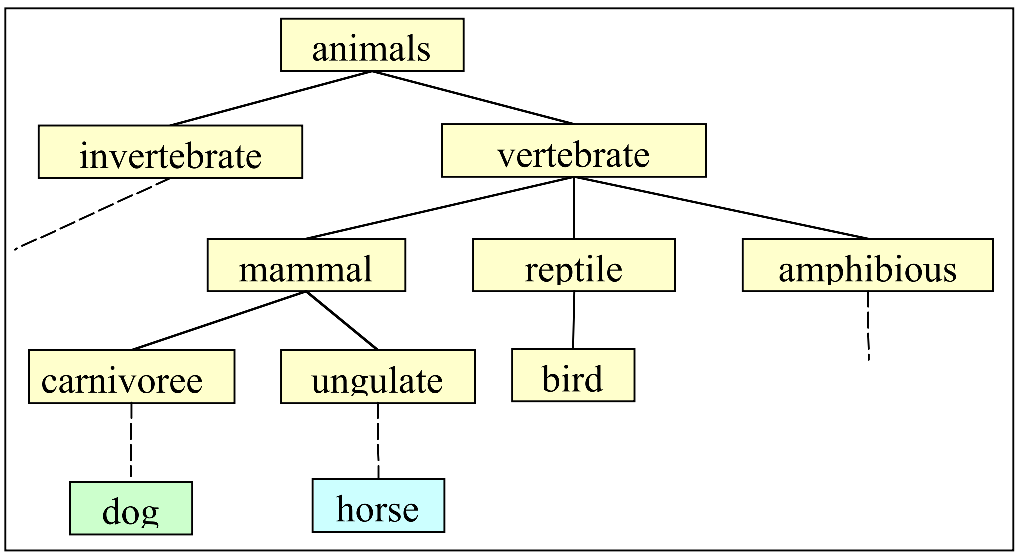

Figure 2: *Taxonomic Classification Ontology: Animal World*

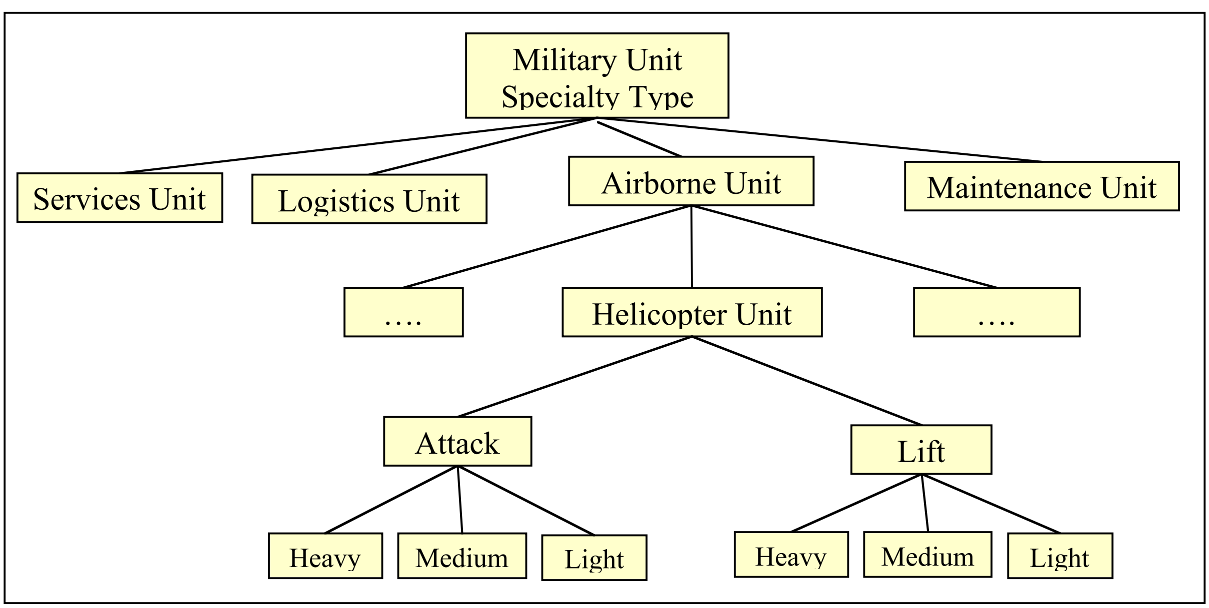

Figure 3: *Military Units Ontology Fragment*

The decision on the right granularity in the formulation of a particular concept is very much dependent on the projected usage patterns for that concept and is often a judgment call. Clustering through the MVP-CA tool allows one to analyze the concept in its operational environment and study its placement in the generalization hierarchy.

- **Competing axes of distinctions for concepts:**

During our analysis we have often found very orthogonal characteristics possessed by a single concept that gives rise to competing axes of distinctions for placement of the concept. It is often a judgment call based on the projected usage of the ontology, as to which choice is the best one to adopt. For example, in a clothing store, the classification of clothes can be done on the gender axis or type axis. For an optimal layout of clothes in the store the classification is likely to be based along the gender axis, that is men's vs. women's. However, the same store, when interfacing with a manufacturing line would organize the items according to the clothes types, that is, pants, shirts, etc.

A very similar problem emerges for choosing the right branch for placement of a concept on the ontological hierarchy. In Figure 3 we have exposed this problem with the placement of helicopter in the lift or attack branch. The properties that need to be defined for the helicopter will change depending on the branch in which it gets placed. The ultimate litmus test for the right placement of such a term will lie in the nature of the application which will use it.

Clustering exposes the "vicinity" terms for a concept, that is, terms that naturally group together due to the nature of the application area in which the concept gets used. We have exposed such opportunities for regrouping and realigning of concepts in the IMMACCS system [Mehrotra (2001), Mehrotra and Bobrovnikoff(2001)] last year.

- **Context of Usage:**

The context in which a concept gets used determines its semantic import. This determines the attributes or properties that the concept needs for its definition. Concept terms that exhibit polysemy is especially notorious because they can have overloaded meanings if they have not been differentiated appropriately in the ontology. A layman's example of polysemy is a word like contract which means physical change in the physics world, but in a legal setting it has the semantic import of a legal document. Another such term is culture which has an overloaded meaning depending on whether one is in the societal context or a biological experiment.

In our experiences with the MVP-CA tool, we have often found usage of lexical reversals on composite words to convey different connotations on the concept. For example, PortalOpen and OpenPortal use the same base concepts Open and Portal, but the first one maybe used in a passive manner to define a state of the system as having an open portal, whereas the second one may be used to provide a more proactive spin on the concept – that is, the act of opening up a portal. Such multiple over loadings on the meaning of terms often makes a knowledge base opaque from the comprehension standpoint. However, we cannot discourage their usage, because there is often only a limited repertoire of base concepts with which we can convey our meaning. What is needed are tools to help distinguish the various aspects of usage of similarly named

concepts. One of the major barriers to the reusability of knowledge bases lies in the inability to identify existing concepts that are relevant to the current task. Often, terms have been coined in the knowledge base with a particular usage in mind and the documentation fails to expose the nuances underlying a term's intended meaning(s). The problem gets worse when terms represent multiple concepts, as it is sometimes difficult to distinguish between overloaded meanings. Clustering can help expose the usage of such terms by showing them in the various contexts in which they occur.

- **Presence of composite concept terms:**

Since it is common practice to join single concept terms to provide variations on a base concept, if the distinctions are not made obvious, or are not documented sufficiently clearly, often the usage of these terms are left to the interpretation of the reader. Especially notorious are terms that are lexically and semantically close, such as, Move and Move-Into lexically distant but semantically close, such as, Move-Into and Enter complementary terms, such as, Move-From and Move-To. In our experience analyzing the spatial slice of Cycorp's Integrated Knowledge Base (IKB)[CYCORP (2002)], clustering exposed many composite terms. One such term, objectFoundInLocation, can take on very different meanings depending on (a) the type of object to be found, (b) the type of place in which one is trying to find the object, and (c) the precise type of "find" that defines success. Thus, the object can be as small as a fly stuck in a cobweb or a large country inside a continent. The object could be considered as found by simply being "near" the location, or "in-among" several other objects, or, alternatively, it might be required to "touch" the desired location. Even though the essence of "find" is common to the axioms using this concept, one needs to be aware of the types of the surrounding terms that are brought to bear for extending the knowledge base in a given context.

The clusters generated by the MVP-CA tool expose the user to axioms that utilize a concept in not only structurally similar manner, but also have similar semantic import. Exposing them in this manner provides an opportunity for building "intermediate" (i.e., virtual) concept nodes to aid both comprehension and retrieval of knowledge base (KB) concepts. In Figure 4 we show the different aspects of usage of objectFoundInLocation

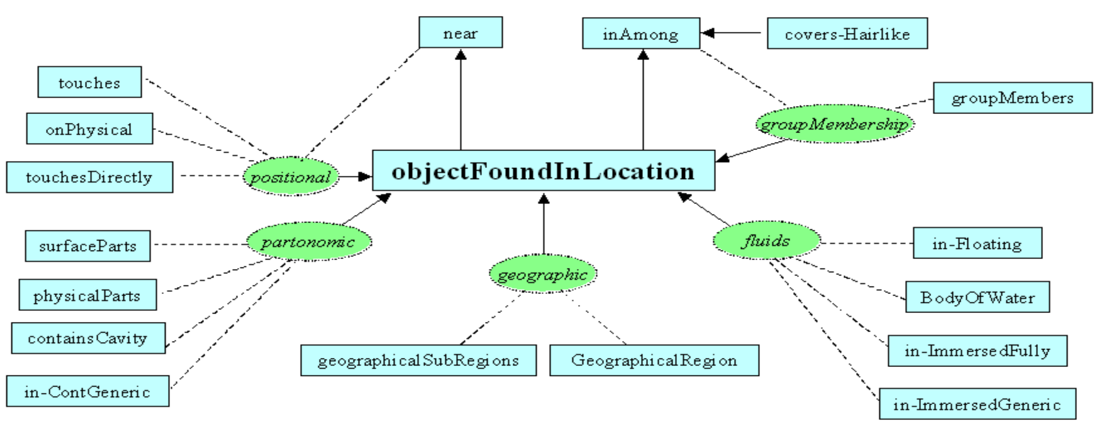

Figure 4: *Intermediate concepts surrounding Cyc term*

through the intermediate concepts – positional, partonomic, geographic, fluids and group

membership. The terms that bunch together under the intermediate concepts imply sharing of similar contexts of usage. These concept nodes can be used to build hierarchies and can serve as guiding or latch points for efficient retrieval during further development of the software system.

- **Presence of common patterns of usage of terms:**

Clusters of structurally similar axioms signal prototypical usage patterns for concept(s). Identification of such regions in the software can be a valuable guide for future extensions of the knowledge base, as well as provide us opportunities for identifying generic, reusable regions in the software. Exposing common functionalities, as well as overlapping contexts across clusters of axioms, reveals opportunities for creation of higher order predicates for axioms, such as macro predicates in Cyc, and templates for groups of axioms [Mehrotra (2202)]. Often the need for these higher-level abstractions can be revealed only ex post facto, that is, after there are enough assertions in the knowledge base to warrant the formation of a higher order axiom. These important knowledge representational issues can impact the long-term utility and quality assurance of the knowledge base.

Subject Matter Experts (SMEs) cannot always be expected to axiomatize their knowledge with existential and universal quantifiers. Often, it is more comfortable for them to express rules in the domain with grounded formulas. These representations can subsequently be analyzed for templating opportunities. MVP-CA clustering can aid the creation of knowledge entry templates by clustering similarly structured grounded axioms. These axiom clusters can then be abstracted to create more sophisticated axioms at a higher conceptual level. Templates set off the static or constant portions of the code from the parameterizable or variable portions of the code in the context of a collection of structurally similar axioms. This sort of scaffolding can help more general axioms to emerge and can help alleviate the knowledge acquisition bottleneck for KB formation by allowing knowledge to be entered at the SME's conceptual comfort level.

Figure 5 shows an example of a possible template that was exposed by clustering

```
(#$implies
   (#$and
      (#$termOfUnit ?CONVEXHULLFN (#$ConvexHullFn ?OBJECT))
      (#$termOfUnit ?CONVEXHULLFN-1 (#$ConvexHullFn ?CONVEXHULLFN)))
   (#$equals ?CONVEXHULLFN ?CONVEXHULLFN-1))

(#$implies
   (#$and
      (#$termOfUnit ?INTERIORFN (#$InteriorFn ?INTERIORFN-1))
      (#$termOfUnit ?INTERIORFN-1 (#$InteriorFn ?ANYOBJECT)))
   (#$equals ?INTERIORFN ?INTERIORFN-1))
```

```
Template:
(#$implies
   (#$and
      (#$<UniqueFn> ?<UNIQUEFN>)
      (#$termOfUnit ?<UNIQUEFN-TERM-1> (?<UNIQUEFN> ?OBJECT))
      (#$termOfUnit ?<UNIQUEFN-TERM-2> (?<UNIQUEFN> ?<UNIQUEFN-RESULT-1>)))
   (#$equals ?<UNIQUEFN-TERM-1> ?<UNIQUEFN-TERM-2>))
```

Figure 5: *Template formation*

Cyc's spatial slice. The two axioms, ConvexHullFn and InteriorFn shown at the top of the figure, are representative of a set of axioms in the abstract spatial relationship cluster that return the same value when invoked. The structural similarity across the axioms is very evident, and can be exploited by formation of the template UniqueFn, shown at the

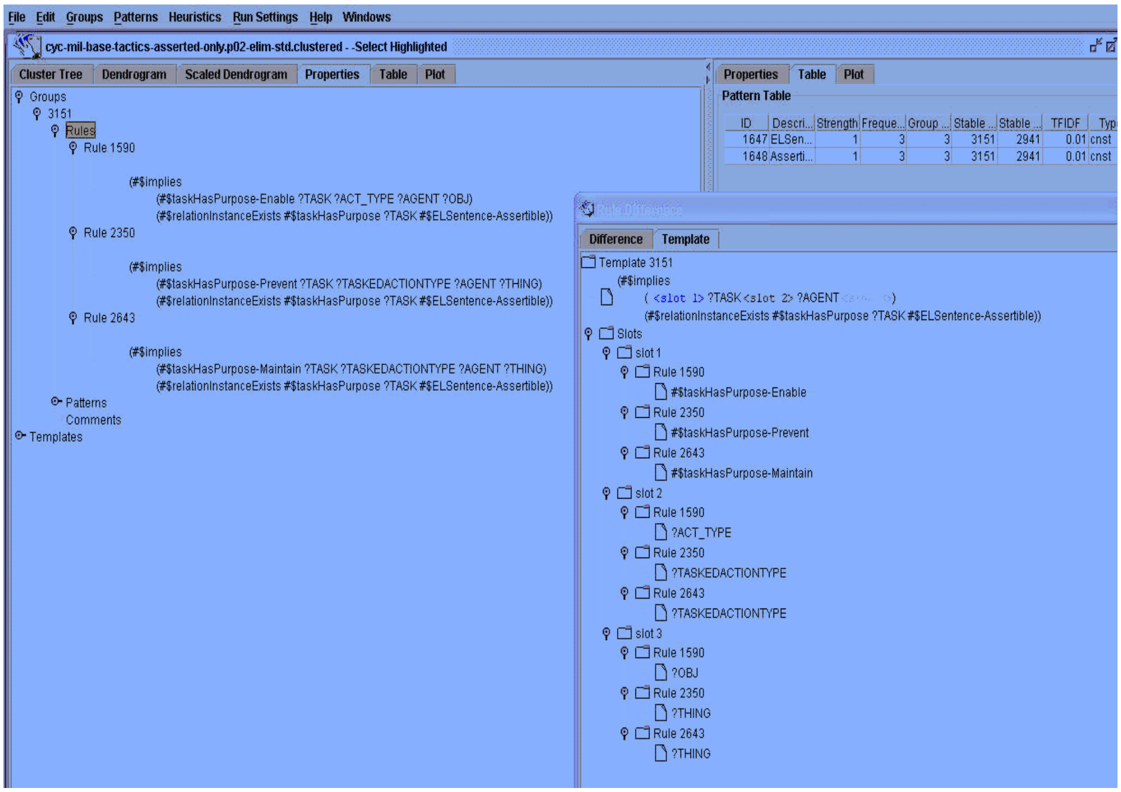

Figure 6: *Snapshot of the Templating Infrastructure of the MVP-CA Tool*

bottom of Figure 5.

Another example of template formation is shown as a snapshot of templating infrastructure from the MVP-CA tool in Figure 6. The template is formed automatically from the tool by performing rule differencing operation on a selected rule set. The cluster selected in Figure 6 shows how different types of tasks, *Enable, Prevent* and *Maintain* have relationship with the predicate *TaskHasPurpose* defined on them. Several types of similarities in the ontology space can be exposed, templated and documented in the current MVP-CA infrastructure. A subset of these findings can be selected for model fragment creation in the Façade Creation Toolkit infrastructure that we discuss next.

V. Façade Creation Tool Technology

The Façade Creation Toolkit (FCT), currently under development at Pragati, is aimed at providing an environment for addressing the creation and reuse of ontologies given the various expositions from the MVP-CA tool [Mehrotra et.al (2002)]. In particular, this tool enables an ontology designer to specialize and combine portions of existing

ontologies into *façades*. Starting from a set of functional requirements specified in natural but restricted English, the FCT guides the user through the entire process of creating a new ontology. The tool provides a significant level of cognitive support for façade construction; however, the user always has the final control.

A façade is a new ontology which is built by modifying pieces of existing ontologies. A model fragment is an embodiment of a "usage pattern" that can be reused in creating new ontologies or façades. A model fragment is therefore a higher level abstraction of patterns that has been extracted through analysis of existing ontologies. Like full ontologies, model fragments and facades are composed of entities and relationships and are displayed by FCT as UML class diagrams. The MF repository consists of model fragments. The user has the final choice of which model fragment addresses his/her needs in the best possible way and would require the least specialization. FCT represents ontologies as UML class diagrams; therefore the MFs are presented in this form.

In its current form the FCT is user-driven from the point of view of selection, specialization and merging of ontologies. The current FCT allows a user to build and modify agent ontologies via a natural-language-based high-level specification of the domain as shown in Figure 7. Currently the high-level specification language captures the agent interest succinctly in terms of a functional requirement expressed in natural language. A template-based approach is used at this point to map the requirements onto attribute-value pairs in the templates. Based on the attribute set extracted via the natural language system, the FCT presents various model fragments (MFs) from the MF repository.

The methodology of constructing a new ontology on an existing one is as follows:

- The file containing the user's functional requirements (expressed in natural language) are displayed in the requirements pane. The user selects a functional requirement for the envisioned façade.

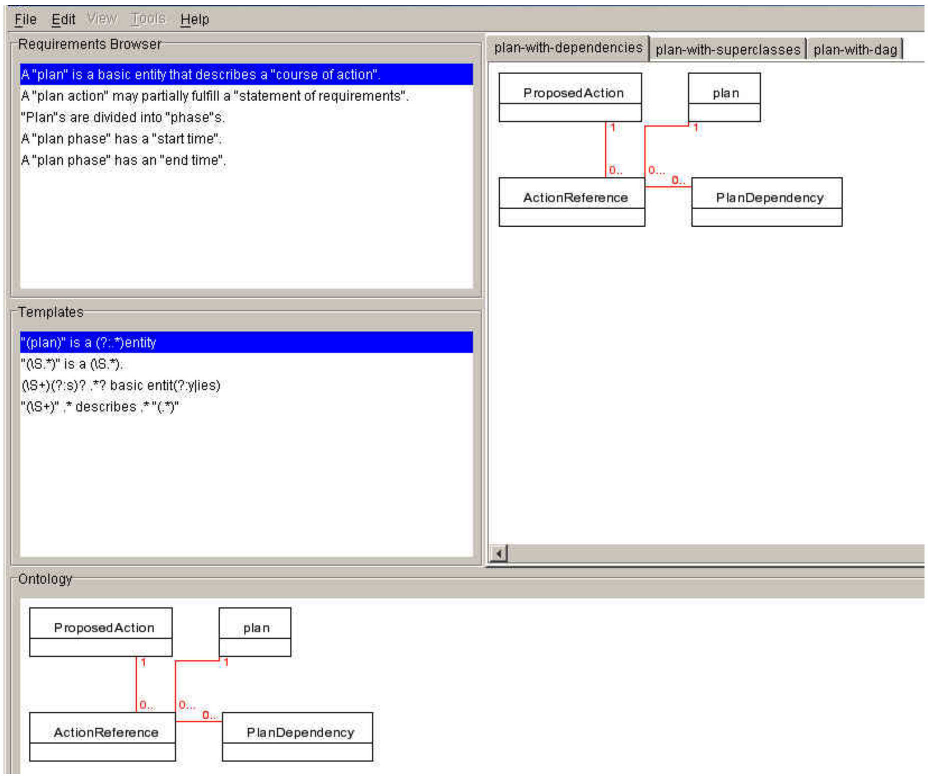

Figure 7: *The FCT interface, displaying natural language requirements (top left), ontology requirements (called templates here, middle left), and a model fragment (top right). The Ontology window (bottom) is used to construct façades.*

- The templates pane displays all the NL templates matching the selected requirement. (Often multiple templates will match a given requirement – based on different interpretations of the same information). The user chooses the most appropriate template.
- The Model Fragments (MF) capable of fulfilling the current requirements is then displayed (the system automatically specializes the fragments based on the text of the functional requirement). The user selects the MF that best addresses his/her current need.
- The selected MF fragment is displayed in a separate workspace. The user can perform a number of operations on the selected MF: editing the entities; merging with previously selected MFs; editing the relationships in the MFs.
- The user repeats the above steps for each of the requirements.
- Once all the requirements have been satisfied, the resulting ontology built in the workspace can be saved.

In its current form the FCT is user-driven from the point of view of selection, specialization and merging of ontologies. The current FCT allows a user to build and modify agent ontologies via a natural-language-based high-level specification of the domain as shown in Figure 7. Currently the high-level specification language captures the agent interest succinctly in terms of a functional requirement expressed in natural language. A template-based approach is used at this point to map the requirements onto attribute-value pairs in the templates. Based on the attribute set extracted via the natural language system, the FCT presents various model fragments (MFs) from the MF repository. FCT has been recently adapted to import ontology fragments from Embarcadero's Describe packages in the form of model fragments. These fragments can be exported to the Describe package as well after modification.

VI. Proposed Round-Trip Software Engineering Methodology

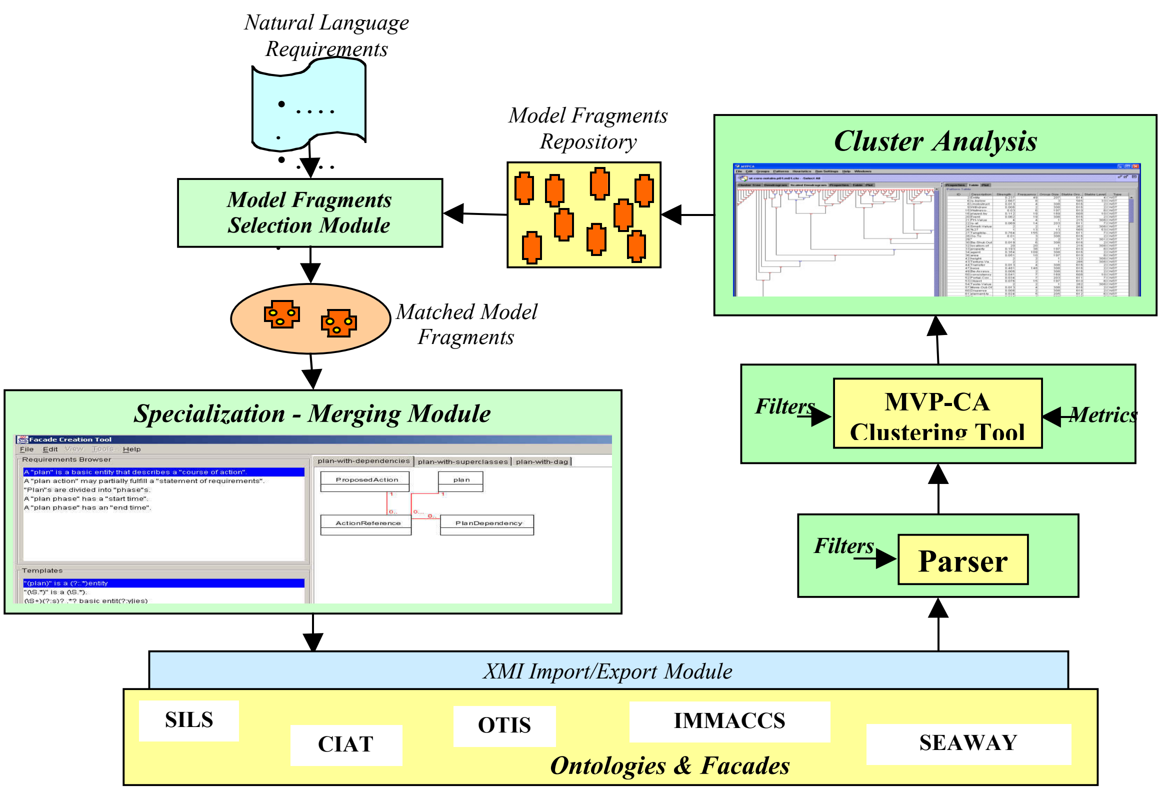

Figure 8: *Architecture of the Integrated Toolset – MVP-CA and FCT for Roundtrip Engineering*

Our proposed framework for maintenance and reuse of ontologies is depicted in Figure 8. The right-hand-side provides the infrastructure for MVP-CA tool. It is envisioned that analysis results from the MVP-CA tool can be captured as model fragments in the model fragment repository of the FCT framework. Several types of similarities in the ontology space can be revealed from the MVP-CA tool and captured in the FCT framework with a view to selecting a subset of them for MF creation. We hope that the output of the clustering tool can become essentially recommendations for new ontological elements. FCT's strength lies in enabling one to break away from the past usage and tailor the objects to the new setting/application. The connection between the

past and the future vision lies then in the model fragments that we propose to the user for a given requirement. There is a judgment call issue here in how we decide **when** such discoveries need to be flagged as reusable. A parallel knowledge representation research issue is **how** we represent the reusable aspects of the fragment. Both of these are open research issues.

We hope that clustering can pull in the different behaviors of the objects through their role and association relationships. As far as possible, if the behavior of objects can be captured in the form of generic role and association declarations, we can try to formulate different criteria for model fragment formation. Extracting model fragments from existing ontologies as well as creating new ones through observed analysis/design patterns is a feature we would like to explore through the FCT. Joining of the two technologies, MVP-CA and FCT can be viewed as a step towards providing the framework within which hard-core reusability issues can be studied.

VII. Conclusions

Based on our experiences in analyzing ontologies, in this paper we have proposed a joint infrastructure to leverage off of two technologies – the Multi-ViewPoint Clustering Analysis Tool as well the Façade Creation Toolkit. MVP-CA technology provides an environment to "mine" for reusable and generalizeable components in the form of model fragments from existing axiomatized ontologies, whereas the Façade Creation Toolkit enables the adaptation and utilization of these model fragments in the form of facades in the target application domain. An interactive and informed approach is proposed for ontology development, maintenance and reuse, so that ontologies can be created in an adaptive manner and the cost of developing multi-agent systems can be reduced substantially.

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Data, Information, and Knowledge in the Context of SILS

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Abstract

Data, information, and knowledge are becoming increasingly common terms in the literature of the software industry. This terminology originated some time ago in the disciplines of cognitive science and artificial intelligence to reference three closely related but distinct concepts. Traditionally, mainstream software engineering has lumped all three concepts together as data and has only recently begun to distinguish between them. Unfortunately, the popular desire to distinguish between data, information, and knowledge within the mainstream has blurred the individual meanings of the words to the point where there is no longer a clear-cut distinction between them for most people. This problem is compounded by the fact that the abstract nature of the associated concepts provides wide latitude for their application.

The goal of this paper is to make these abstract concepts more concrete by providing examples of their usage taken directly from the design and implementation of the Shipboard Integration of Logistics Systems (SILS), an ONR project sponsored by Dr. Phillip Abraham. This paper does not claim or intend to provide definitive definitions of these terms; rather it seeks to provide a cognitive framework for thinking about these concepts from which observations and conclusions can be made about the differences and relationships between the individual concepts.

Keywords

Data, Information, Knowledge, Ontology, Object, Object Model, ONR, SILS, UML

Introduction

The Shipboard Integration of Logistics Systems (SILS) is a concept developed by Dr. Phillip Abraham of ONR. SILS can be explained as integrating shipboard and supporting shore side systems for information sharing as an enabling platform for the development of key technologies geared towards providing much more efficient and timely logistics. This in turn provides higher levels of mission readiness that are sustainable over longer periods. Examples of these technologies include: intelligent software agents, predictive failure technologies, distance support, and self-sensing diagnostic capabilities. Many of these technologies require information sharing to derive, share, and apply the dynamically growing bodies of knowledge that they embody to the problem of naval logistics.

The SILS concept is manifest in the design of a series of decision support systems based on the Integrated Collaborative Decision Model (ICDM); a collection of guiding principles, architectural components, and tools developed by the Collaborative Agent Design Research

Center for the implementation of agent based decision support systems. These systems are as follows:

1. The Collaborative Agent-based Control and Help System (COACH) assists naval servicemen in the performance of time critical repairs.
2. The Ordnance Tracking and Information System (OTIS) assists ordnance officers in the planning, tracking, and implementation of ordnance movements aboard aircraft carriers.
3. The Mission Readiness Analysis Toolkit (MRAT) assists the commanding officer of Navy ships and their department heads in assessing and preparing the readiness of their ship for combat.

This paper begins by providing some background information covering the concept of an ontology and the progressive evolution of a single ontological model framework developed in the context of the three SILS decision support systems: COACH, OTIS, and MRAT. The conventions employed in the text and figures of the paper are also provided. This is followed by a description of the overarching framework that distinguishes and relates the concepts of data, information, and knowledge in the context of SILS. Next, successive sections provide general descriptions of data, information, and knowledge, and introduce the corresponding top-level model elements, derived directly from the abstract conceptualization that the framework provides for each. Then an example is provided that describes the application of the generalized SILS model to represent and reason about a specific real world problem. The paper concludes by making observations about the nature of data, information, and knowledge by utilizing the presented model and example as an environment for their contemplation.

Background

An ontology is a conceptual model of the world that can be used to create virtual emulations of it within the bounds of the application domains of a particular system. Concepts in common between these three ICDM systems are all implemented with the same ontological elements. To this common core, non-overlapping extensions that address the concepts unique to an individual system are added. Information sharing amongst systems is accomplished most efficiently and accurately with common ontological elements. By sharing common ontological elements, translation is not required for these systems to exchange information, which results in a more efficient exchange without ambiguity or loss of information.

COACH presented the ontology development team with a domain that potentially included all the equipment in the U.S. Navy. The team looked to apply the concepts espoused by Martin Fowler in his book Analysis Patterns, reusable object models (Fowler 1997a) to develop models independent of any particular piece of equipment that could be extended at runtime by users in the field to deal with new types of military equipment or variations on existing types as they were introduced. A key feature of the COACH model was the use of a knowledge instance model to allow the ontology to be extended at runtime. With OTIS, the team found a large percentage of the precompiled class model from COACH could be reused, given a knowledge instance model to tailor it to the domain of ordnance handling aboard U.S. Navy aircraft carriers. During the implementation of the OTIS model, the concepts developed for the COACH model evolved resulting in a formalized split between the operational level of the model and the

knowledge level. With SILS, the team was again able to reuse large portions of the evolving generic ontology. SILS introduced a new aspect in that it is primarily driven by external system data inputs. This resulted in the formalized incorporation of the concept of data in the model framework. The concepts associated with the OTIS operational level also evolved to result in a model framework that formally distinguishes the individual concepts of data, information, and knowledge.

This paper assumes but does not require a rudimentary knowledge of the basic concepts of object-oriented modeling. A good introduction to this subject can be found in Inside the Object Model by David Papurt (Papurt 1995). All the figures in this paper use a small subset of the graphical object-oriented notations defined by the Unified Modeling Language (UML). A brief overview of the UML notations employed in this paper is provided in Figure 1. Pertinent characteristics of the different constructs are described as the constructs are introduced throughout the document. A concise summary of UML can be found in UML Distilled by Martin Fowler (Fowler 1997b). The UML based figures in this document provide only the minimum level of detail necessary to understand the concepts under discussion, and therefore they leave off many of the details typical in UML diagrams such as role names and multiplicity constraints. This paper capitalizes and italicizes ontological class names and quotes object instance names.

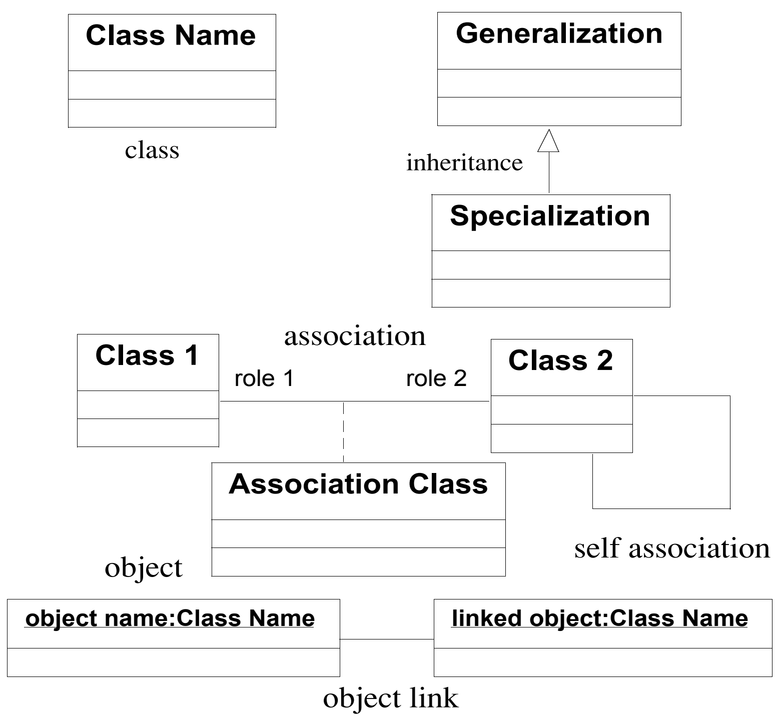

Figure 1. UML Notions Employed in this Paper

SILS Model Framework

The SILS Model Framework, depicted in Figure 2, provides top-level concepts and a structure for the development and implementation of ontologies intended to model the core problem domain for the encompassing decision support system. It is rooted in a higher-level system framework that provides structural representation for those elements of decision support system implementation that are independent of any particular domain. Examples include concepts such as *User*, *Access Permission*, and *Session*. *Sessions* are used to partition *Domain Objects* into disjoint worlds (sets) to support such things as training scenarios and what if experiments independent from the primary operational picture, but within the same conceptual and physical system environment. All objects used to represent the core problem domain of the system are *Domain Objects*, which serves as the common base class that roots the SILS Model Framework and captures all relationships with the external context provided by the SILS System Framework.

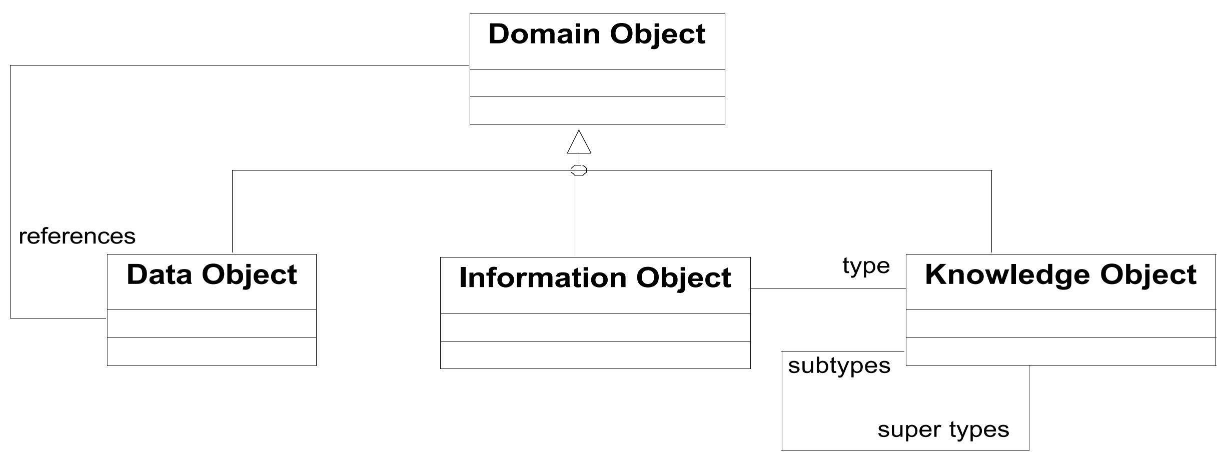

Figure 2. Model Framework

In addition to external context, *Domain Object* supports those characteristics of the representation (ontology) and implementation (object model) shared by all objects within the problem domain representation. The model defines three types of *Domain Object*: *Data Object, Information Object, and Knowledge Object*, which respectively model the distinct real world concepts of data, information, and knowledge within the virtual context of a SILS system implementation. The model defines three associations to capture the key relationships between these concepts.

All *Information Objects* have an association with at least one *Knowledge Object* that defines the logical type or types of the *Information Object.* This will be referred to as the knowledge level type of the *Information Object* to distinguish it from the standard classification mechanism indicated by the closed arrow in a UML diagram. *Information Objects* use their knowledge level type in conjunction with the standard classification mechanism to augment the fixed meta-model provided by the object oriented implementation environment. Using this approach the knowledge level serves as a dynamic meta-model that supports meta-level relationships, and allows for dynamic and multiple classification schemes that support runtime extensions. The subtype supertype association is used to compose *Knowledge Objects* into classification taxonomies upon which much reasoning can take place. Data objects are used to hold

standardized reference data defined by the US Department of Defense (DOD) or imported from external systems. *Domain Objects* may associate *Data Objects* in order to supplement the information carried by their attributes. In this manner, the associated data may be elevated to the level of information.

SILS Data Model

Data consists of words or numbers without relationships; thereby, requiring the context to be inferred to provide meaning. A random stream of words or numbers can be thought of as raw data while a fixed sequence of words and numbers can be thought of as structured data. Structured data is the primary building block upon which information is built; however, the data must be structured to correspond to the real world entities within the domain in order to build information. Given structured data corresponding to entities within the domain, the transition to information is made by adding the relationships between entities to pin down the situational context to such an extent that no inferences are required to provide meaning. These ideas are discussed in depth in (Pohl 2000). Data is the primary means by which information and knowledge are communicated as the software systems, agents, or human beings participating in the communication typically have differing ontologies. Differing ontologies necessitates the use of inferences by the sender to decide what to send and by the receiver to translate it into his internal ontology from which he makes sense of the world in which he lives.

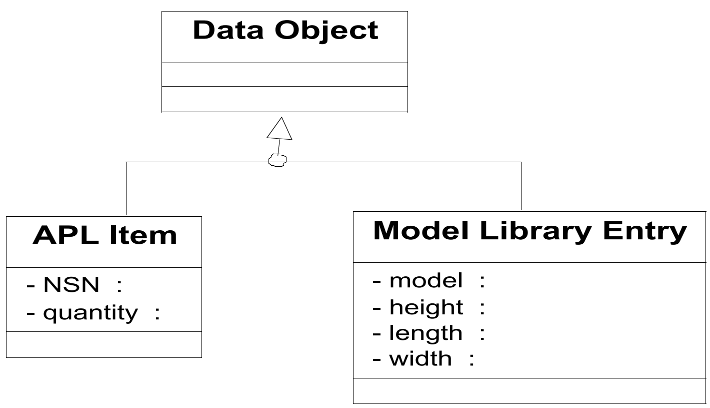

Figure 3. Data Model Fragment

The SILS Data Model Fragment shows two specializations of *Data Object*: *APL Item* and *Model Library Entry*. *Data Object* is an element of the SILS Model Framework that is depicted in Figure 2. APL Item represents an entry in the Allowance Parts List for a Navy Ship. This list specifies the type, by National Stock Number (NSN) and quantity of the spare parts to be carried aboard ship. When represented as data a human or software agent must already know what ship the APL corresponds too, perhaps by assuming it references the ship upon which the data server is resident. By linking a specific APL Item to a specific ship, perhaps by using the *Domain Object* reference association, an inference need not be made. *Model Library Entry* is a line item in a standardized US Army Catalog of vehicle and equipment dimensions. An experienced human operator knows that models map to National Stock Numbers (NSNs) and could therefore use a *Model to NSN Map Entry Data Object* (not shown) to correlate *APL Item* objects to *Model*

Library Entry objects in order to access the dimensions of an *APL Item*. By associating APL Item objects to Model Library Entry objects the dimensions of an APL Item could be directly obtained without the inferences and data joins previously required; thereby, providing information rather than data in this instance.

SILS Information Model

This section describes the simplified top-level fragment of the SILS Object Model for representing information that is depicted in Figure 4. Information consists of structured data with relationships defined by an explicit conceptualization known as an ontology. The relationships provide context and thus meaning. Information is declarative in nature and thus associated with the present and the past.

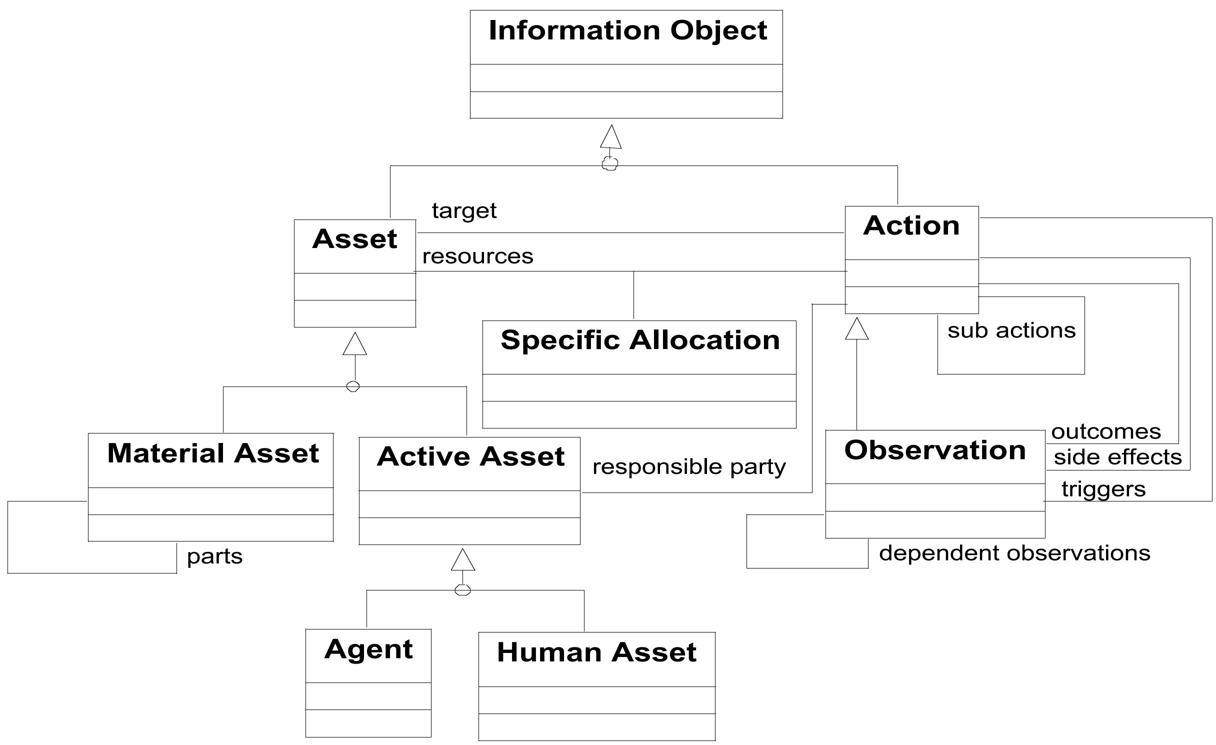

Figure 4. Information Model Fragment

This model fragment expands the concept of information in the context of SILS by defining concrete specializations of *Information Object*. *Information Object* is an element of the SILS Model Framework that is depicted in Figure 2. Key to understanding the SILS Information Model is the concept that each *Information Object* has a knowledge level type that provides it with logical meaning as discussed in SILS Model Framework section.

The SILS Information Model Fragment defines three primary types of *Information Object*: *Asset*, *Action*, and *Observation*. An *Action* is used to represent the performance of a *Protocol* as indicated by the associated knowledge level type to a *Protocol Knowledge Object.* Key attributes of *Action* (not shown) are the start time and end time, which may be actual or planned depending

on the value of the status attribute of *Action.* An *Action* may be further decomposed in to sub actions as indicated by the association with itself.

An *Asset* is used to represent concrete entities within the domain the logical type of which is indicated by the knowledge level type association to an *Asset Type*. Two types of *Asset* are defined: *Material Asset* and *Active Asset*. *Material Assets* associate with *Asset Types* that define things such as ships, guns, uniforms, petroleum products, and types of food. A *Material Asset* may contain parts, which are themselves *Material Assets* as indicated by the association with itself. *Active Assets* are things that may act to change the environment. Two types of *Active Asset* are defined: *Human Asset*, which may be a *Person* or an *Organization*, and *Agent*, which corresponds to a software-based entity.

An *Observation* is used to represent the occurrence of some *Phenomenon* within the domain as indicated by the associated knowledge level type to a *Phenomenon Knowledge Object*. Note that an *Observation* is an *Action* and therefore has all the characteristics and relationships indicated for an *Action*. An *Observation* may indicate the *Observations* upon which it depends by the association with itself. This is useful for inferred *Observations* as it allows the *Observations* upon which an inference was based to be recorded. If one or more of the dependent *Observations* are invalidated, it may be an indication that the inferred *Observation* needs to be invalidated as well.

Now that the individual object types defined in the SILS Information Model Fragment have been described, meaningful descriptions of the associated relationships can be provided. Looking again at *Action* it can be seen that an *Action* may optionally (note that association multiplicities are not depicted here for the sake of compactness) be performed on an *Asset*, and may indicate resources used or allocated, depending on the value of the Action type attribute, during or for the execution of the *Action*. Resources are associated by means of an association class, which allows attributes to be tied to the association itself. This allows, for example, the representation of the allocation of an *Asset* to an *Action* for a block of time that differs from the block of time over which the *Action* occurs. Associations also indicate the *Active Object*: *Person*, *Organization*, or *Agent* responsible for performing it. With the addition of these relationships, one can see how the individual sets of structured data represented by *Action* and *Asset* are elevated to the level of information.

The transformation to information becomes even more apparent when the associations between *Action* and *Observation* are examined. *Action* triggers allow the *Observations* that prompted the *Action* to be recorded. For example, an *Observation* of the phenomenon 'broken' on generator number two can be recorded as the trigger for an *Action* using the *Protocol* 'diagnose generator'. Side effects and results can also be indicated. Continuing on the previous example it can be indicated that the *Action* to diagnose the generator resulted in ship power circuit number 4 being shut down from 4 to 5 o'clock as indicated by an *Observation* with start time 4 and end time 5 on the *Asset* 'power circuit number 4' of the *Phenomenon* 'shut down'. Finally, a result could be indicated by a result association (link) to an *Observation* of the 'generator main bearing' of the *Phenomenon* 'requires replacement'.

SILS Knowledge Model

This section describes the simplified top-level fragment of the SILS Object Model for representing knowledge that is depicted in Figure 5. *Knowledge Object* is an element of the SILS Model Framework that is depicted in Figure 2. Knowledge consists of information-based inferences that are predictive in nature and thus associated with the future.

This model fragment expands the concept of knowledge in the context of SILS by defining three concrete specializations of *Knowledge Object*: *Asset Type*, *Protocol*, and *Phenomenon* that serve as the respective targets of knowledge level type associations for the *Information Objects*: *Asset*, *Action*, and *Observation*.

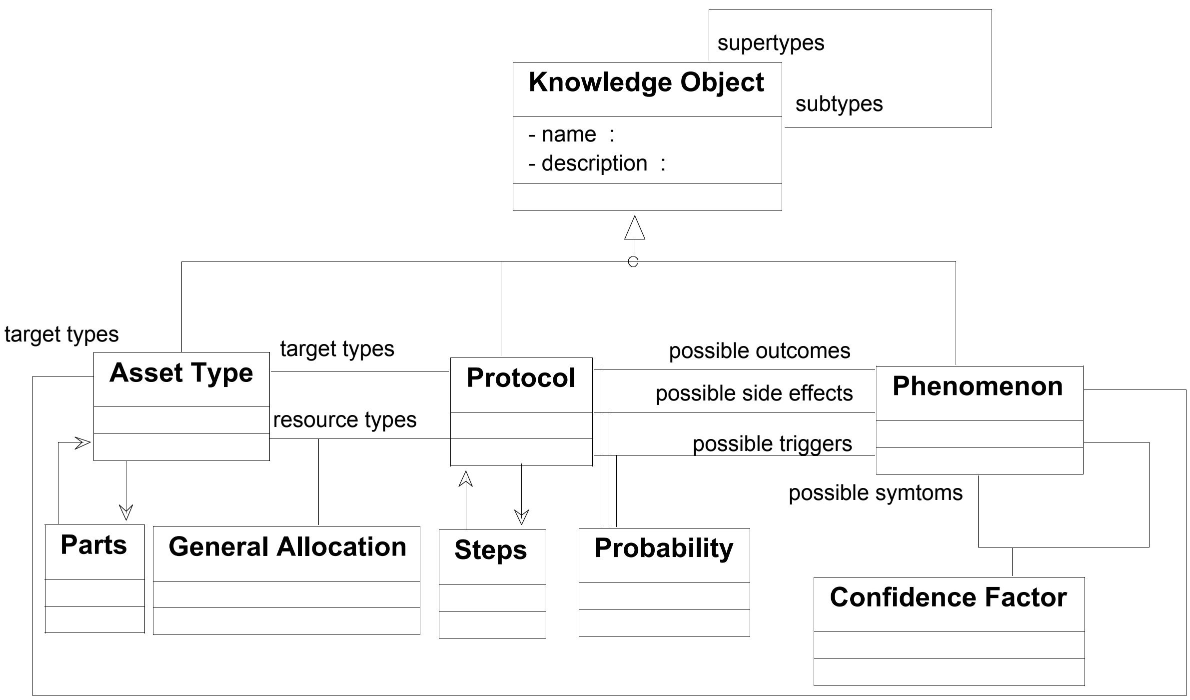

Figure 5. Knowledge Model Fragment

A *Protocol* is used to represent standard procedures or processes independent of the *Actions* that employ them. It may be further decomposed into steps as indicated by the association with itself through the steps collection class. *Protocol* steps, which are also *Protocol* objects, mirror the sub actions of *Action*, but cannot be implemented with self-association, which requires referenced objects to be unique. Every *Action*, including sub actions, is unique while the same *Protocol* could be used repeatedly to build up a higher-level *Protocol*. For instance, the *Protocol* 'rotate tires' may use the unique *Protocol* 'remove wheel' four times. If the *Action* object that represents the execution of the 'rotate tires' *Protocol* is decomposed in the same manner (typical but not required), it would associate as sub actions four unique *Actions*, performed at different times or by different people, that all reference the same 'remove wheel' *Protocol*. *Protocol* uses the target types association to indicate the applicable *Asset Types*. The *Asset Types* required to implement it are indicated by the *General Allocation* association class, which provides attributes to indicate quantity and time.

An *Asset Type* is used to represent the types of concrete entities within the domain. Just as a specific *Material Asset* object may contain specific parts, a particular *Asset Type* may contain a collection of part types. Similar to the situation with *Protocol*, *Asset Type* cannot use self-association to indicate part types due to the uniqueness constraint on associations; however, since part order does not matter only one entry per type of part along with an indication of quantity is required.

Another point of interest involves the absence of classes derived from *Asset Type* in the knowledge model in contrast to the derivation tree off *Asset* in the information model which contains four classes: *Material Asset*, *Active Asset*, *Human Asset*, and *Agent*. The implementation paradigm employed by the SILS Model does not utilize the inheritance mechanisms provided by object oriented implementation languages as the primary classification mechanism for *Information Objects*. The language provided mechanism is used only to add the attributes or associations required by the implementation. Logical classification for *Information Objects* is provided by constrained associations to object instances in the knowledge level. While logical classification for *Knowledge Objects* is implemented by linking object instances using the subtypes supertypes association of *Knowledge Object*.

A Phenomenon is used to represent things that can be observed within the domain. Just as an *Observation* may indicate dependent *Observations* though self-association, *Phenomenon* objects may indicate symptomatic information. For example, radio (*Asset Type*) 'does not work' (*Phenomenon*) could be symptomatically linked to battery (*Asset Type*) 'is dead' (*Phenomenon*). As with *Asset Type* and *Protocol*, a more complex self-association mechanism is employed for *Phenomenon* in the knowledge model than for *Observation* in the information model, but for a different reason. In the information model the *Observations* used to infer another *Observation* may be noted. In the knowledge model, it is the probability that one *Phenomenon* infers another that is being noted. In this case, uniqueness is not an issue so an association class is employed to add a probabilistic attribute such as a confidence factor to the symptomatic links between *Phenomenon* objects. This type of probabilistic association is common to the knowledge model.

Protocol and *Phenomenon* have similar relationships to those between *Action* and *Observation* in the information model. Where associations between *Action* and *Observation* provide triggers, side effects, and outcomes, associations between *Protocol* and *Phenomenon* provide possible triggers, possible side effects, and possible outcomes. All of these knowledge model associations utilize an association class to provide probabilistic measures of the individual possibilities. This paper presents a simplified model for the sake of brevity and understanding. The actual SILS model provides additional representational machinery for grouping outcomes side effects, and triggers in order to indicate things like the outcome will be X half of the time or Y and Z the other half of the time.

Object Instance Example

This section presents a simple example intended to clarify the concepts presented thus far. The first step in tailoring the SILS object model to a particular domain is to develop a knowledge

instance model from the knowledge model classes. Rather than providing a knowledge instance model fragment from one of the SILS systems: COACH, OTIS, or MRAT, this example will apply the SILS model to the domain of medical diagnosis, which a broader audience can easily relate too.

First, a phenomenological taxonomy is developed using the subtypes super types association of inherent to all *Knowledge Objects*. Note that the classes in the SILS object models are not reasoned on directly, but rather serve as templates for creating instances upon which reasoning may occur. A simple taxonomy and the knowledge model classes from which it was derived are shown in Figure 6. This hierarchy shows that an 'Infection' is a type of 'illness' and that an 'Infection' may be either a 'Bacterial Infection' or a 'Viral Infection'. In order to demonstrate the ability for reasoning on the taxonomic structures common to the representation of knowledge, consider a presence *Observation* (an *Observation* can record the presence or absence of a *Phenomenon*) posted for a person named John (information model *Human Asset* instance) on the 'Infection' *Phenomenon.* Also, consider an absence Observation posted for a person named Jane on the same *Phenomenon*. Presence observations propagate up the tree so that an intelligent agent can easily conclude that not only does John have an infection he has an illness as well and all that it entails; however it is not know it the infection is bacterial or viral. Similarly, absence observations propagate down the tree. In the context of the example, it is observed that Jane does not have an 'Infection' so one can say Jane does not have a 'Bacterial Infection' or 'Viral Infection' as well; however, at this point is cannot be determined whether or not she has an 'illness'.

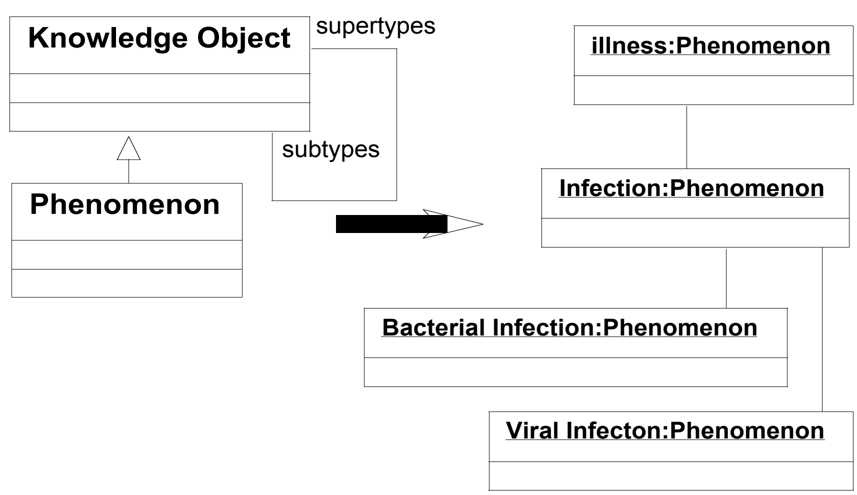

Figure 6. Phenomenological Hierarchy

The next step is to tie these phenomena to symptomatic information. Note that a symptom is also a *Phenomenon* that may be resident is some taxonomy. In this example, 'Infection' is linked to 'High Fever' and 'Viral Infection' is linked to 'Sore Muscles' as show in Figure 7. The probabilistic information associated with the links and the role names has been left off for simplicity's sake. Note that since a 'Viral infection' is also an 'Infection' as indicated by the super types subtypes links depicted in Figure 6. This relationship indicates that that a 'Viral

Infection' shares the characteristics of an 'Infection' or in this particular case also has 'High Fever' as a symptom, but adds new characteristics, the symptom of 'Sore Muscles' in this case, which are not characteristics of the *Phenomenon* 'Infection'.

To finish the knowledge instance model portion of the example that tailors the SILS Object Model to a limited portion of the domain of medical diagnosis, the representative *Protocol*

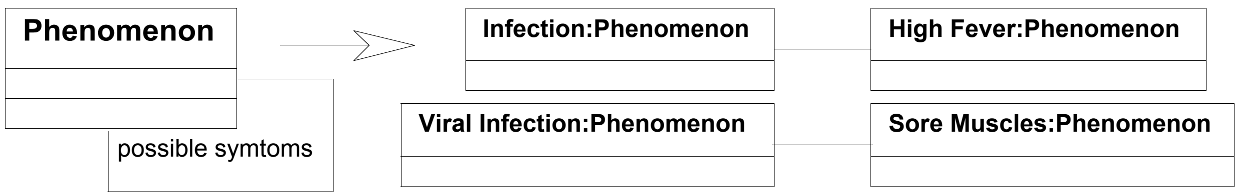

Figure 7. Symptomatic Links

objects: 'Measure Body Temperature' and 'Check for Sore Muscles' are defined. The *Phenomenon* 'Illness' is linked as a trigger to the Protocol 'Measure Body Temperature', and the *Phenomenon* 'Infection' is linked as a trigger to the *Protocol* 'Check for Sore Muscles' as shown in Figure 8. As before, the super type subtype link between *Phenomenon* objects 'illness' and 'Infection' indicate that the *Protocol* 'Check for High Fever' is triggered by the *Phenomenon* 'Infection' as well as 'illness'; however, only the *Phenomenon* 'Infection' is a trigger for the *Protocol* 'Check for Sore Muscles'.

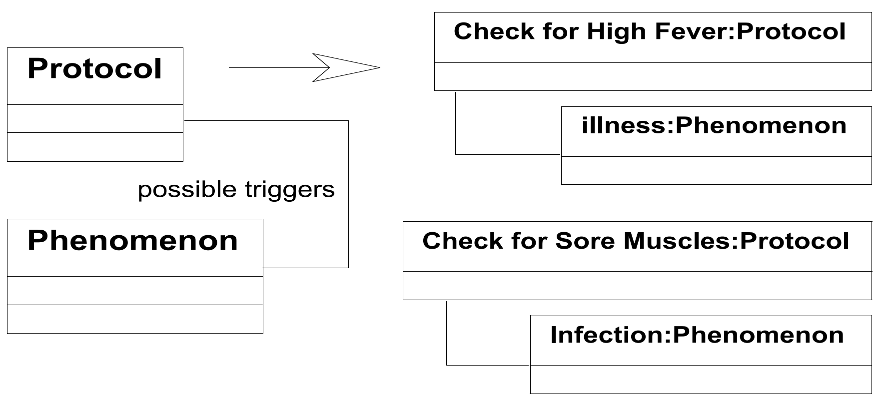

Figure 8. Protocol Triggers

With a knowledge instance model defined, the SILS Information Model can be used to record information and reason on this limited domain of medical diagnosis. First, the example records an observation that the *Person*, where *Person* is a SILS Information Model specialization of *Human Asset*, Mike Zang has indicated that he is feeling ill as shown in Figure 9.

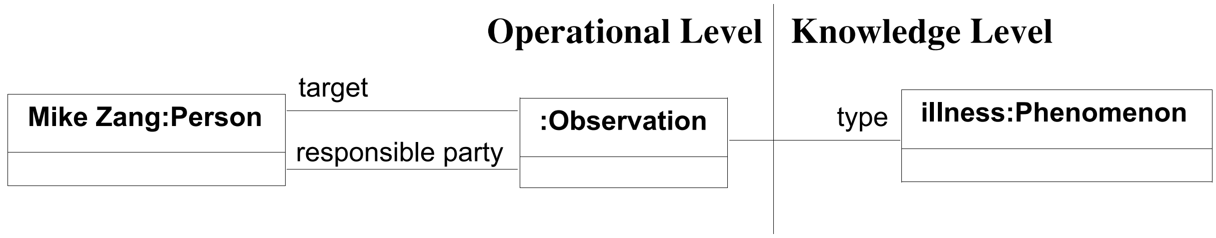

Figure 9. Illness Observation

A person named John Smith then measures the body temperature of Mike, prompted by the triggering *Phenomenon* of 'illness' for the *Protocol* 'Measure Body Temperature' in the knowledge instance model of the example, as shown in Figure 8. The outcome of this *Action* is the *Observation* by John Smith that Mike Zang has a 'High Fever'. These information postings are shown in Figure 10.

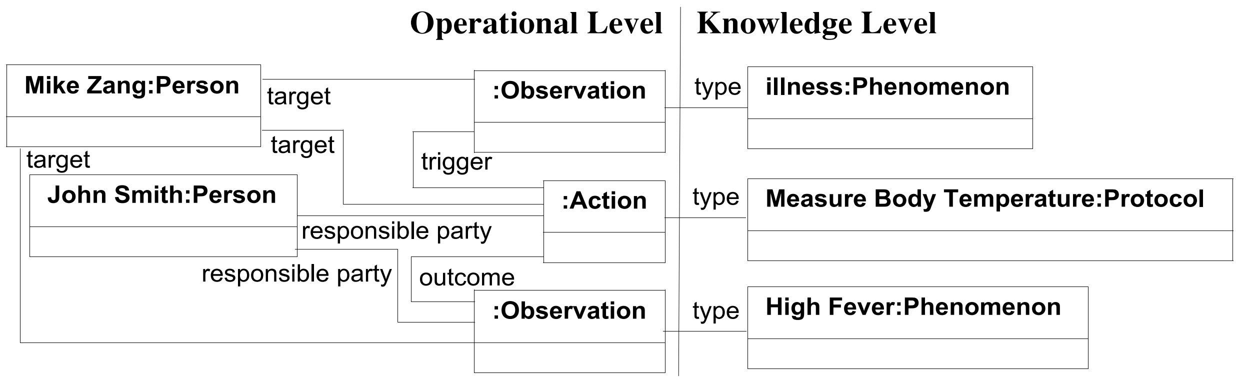

Figure 10. High Fever Observation

'High Fever' is indicated as a symptom of 'Infection' (see Figure 7), a trigger (see Figure 8) that prompts John Smith to make an *Observation* of 'Infection' then perform the *Action* of 'Check for Sore Muscles' on Mike with the outcome *Observation* that Mike does indeed have 'Sore Muscles'. These information postings are shown in Figure 11.

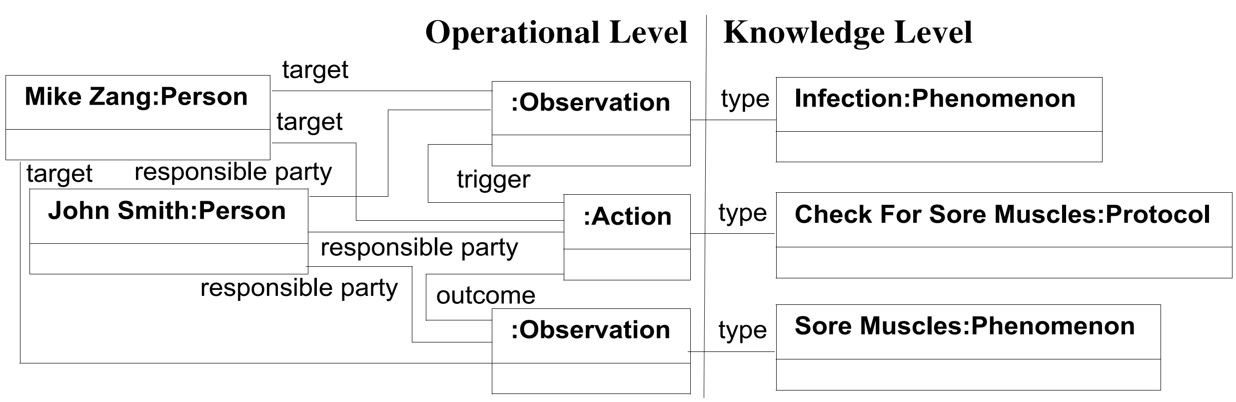

Figure 11. Sore Muscles Observation

Using the symptomatic knowledge that 'High Fever' and 'Sore Muscles' indicate a 'Viral Infection' (shown in Figure 7), a 'Medical Diagnostic' *Agent* posts an *Observation* that it thinks Mike Zang has a 'Viral Infection', as shown in Figure 12.

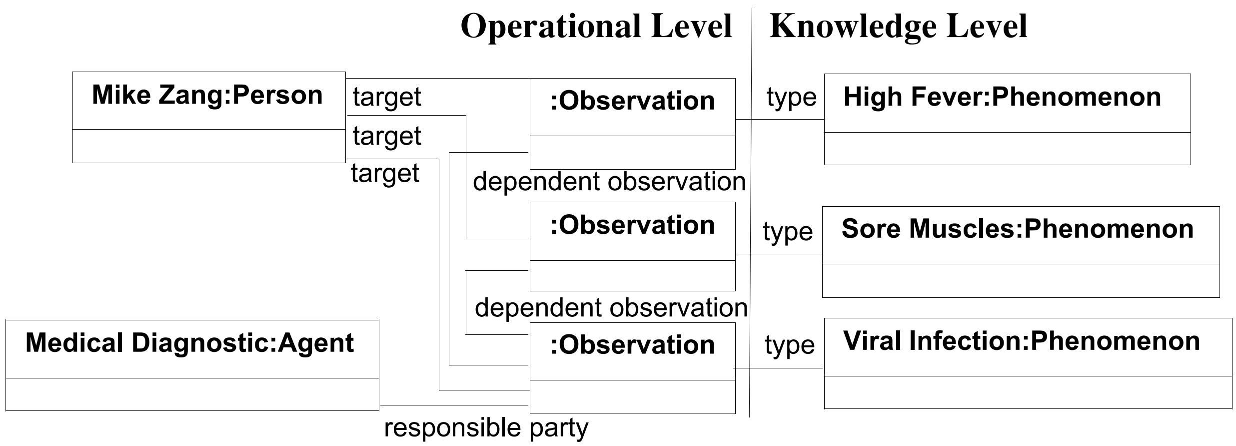

Figure 12. Agent Diagnosis of Viral Infection

Observations

While some standard characteristics of the individual concepts of data, information, and knowledge have been provided, it can still be difficult for one to precisely pin down the differences. This is partially due to the fact that their nature can vary due to the context in which the terms are applied. The clean separation of data, information, and knowledge within the SILS Object Model provides an excellent environment to glean insightful observations about the nature of these concepts in the context of SILS that may carry over to other environments as well. This section concludes the paper by listing and describing some of the observations made by the author as his team developed the SILS model and he worked to describe it in the previous sections of this paper. The reader is encouraged to play with the model by extending it or making up example instances to see what additional observations can be derived.

Knowledge is derived from information. As *Actions* are resourced through associations to *Assets*, the corresponding *Asset Types* can be associated to the *Protocol* of the *Action* or the probabilities of the existing link can be modified using Bayes Law for example. In this manner, knowledge can be learned by observing operational information.

Information is dependent on knowledge for meaning. An *Action* or *Observation* is meaningless without the associated *Protocol* or *Phenomenon*. One could imply that something was done in the case of an *Action* with no knowledge level type but what was done could not be implied. Similarly one could imply that something was seen, measured, or inferred in the case of an *Observation* with no knowledge level type but what that something was could not be implied.

Information is a simplified reflection of knowledge. One can see the close parallels between the information and knowledge model fragments. While it appears the information model fragment has more classes, one must remember that the knowledge level of the model acts as a

meta-level for information. While there is only one *Action* class on the operational side of the model there are a practically limitless number of *Protocols* with which *Action* objects may associate.

Knowledge exhibits more complex associations than information. This observation is exhibited in two ways. First, self associations in the knowledge model must typically be implemented with reference objects or association lists as they may often associate the same object more than once, while the self associations in the information model can use the standard set implementation, as it is rarely the case that an information object needs to associate with itself. Second, associations between knowledge objects are typically probabilistic while those between information objects are direct.

Knowledge is more dependent on the domain than information. *Actions*, *Observations*, and *Assets* apply to just about any domain one can think of while the corresponding knowledge level entities *Protocol*, *Phenomenon*, and *Asset Type* can vary drastically from one domain to another.

Information recorded in error should be invalidated rather than destroyed or modified. This becomes evident when using the model. Consider the medical diagnosis example. Once the 'viral infection' diagnosis has been made it is likely this will be linked as a trigger for some sort of treatment *Action*. If the diagnosis turns out to be wrong it cannot simply be modified to point to a new *Protocol* or even destroyed, as the reasoning behind the treatment must be retained to justify the treatment that could now be incorrect given the new information.

Invalid knowledge should be temporally modified or destroyed. This only applies to temporal systems that allow one to go back in time. Take the diagnostic example again. Diagnoses are made based on the knowledge of the times, which can change dramatically over time particularly in the area of medical diagnostics. This can be dealt with if all knowledge level objects and association classes have activation and deactivation dates, for example. In this manner, one can correctly judge past decisions based on the knowledge available at the time the decisions were made.

New information refines knowledge. This is evident in the probabilistic associations of the knowledge level. If a certain *Protocol* provides the option of two different types of tool with which to implement it, every time an *Action* records the use of tool X instead of tool Y, the probability that associates the type of tool X to the *Protocol* increases while that associated with the type of tool Y decreases.

New knowledge allows a more precise specification of information. Consider again the medical diagnosis example. The Protocol 'Measure Body Temperature' could be extended with new knowledge that partitions 'Measure Body Temperature' into 'Measure Body Temperature Orally', and 'Measure Body Temperature Aurally' each of which has different margins for error. Using one of these new knowledge level *Protocols*, the example action on 'Measure Body Temperature' could be more precisely specified.

New information is easily identified whereas new knowledge is not. New information is always unique by definition. But consider for example a user of the model wishing to post an

observation that his car engine is 'busted'; he does not find an existing 'busted' *Phenomenon* and therefore adds a new one. However the Phenomenon 'broken' did exist. Are 'broken' and 'busted' the same? It is hard to say although a detailed study of the associated knowledge could help. For example, do they apply to the same set of *Asset Types*? This is a difficult issue to solve particularly if the associated system requires support for knowledge level extensions by the end users.

Information does not combine like knowledge. Information by definition is unique so that if two equally large collections of information are combined the result is simply twice the amount of information. Combining knowledge is much more complicated as it first involves identifying identical pieces of knowledge, particularly if dynamic extensions have been allowed, and then involves the combining of the probabilistic data associated with knowledge level associations.

Data referenced by information becomes information. Since an *Information Object* is placed in context by the associations it exhibits, data references by it will be placed in the same or similar context and are therefore raised to the level of information.

Standardized Data is more appropriately linked to Knowledge than to Information. The standardized reference data employed by the DOD and other organizations capture general not specific characteristics. Consider the *Model Library Entry* example, an example entry might provide dimensions for a model of vehicle, say a humvee in the ambulance configuration. A humvee is not a specific *Asset* (operational level) as in Mike's humvee but an *Asset Type* (knowledge level).

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